The Center for Nanotechnology in Society at Arizona State University

NSF #0937591  September 1, 2013 – August 31, 2014

PI:  David H. Guston, Arizona State University

Co-PIs:  Elizabeth Corley, Arizona State University
           Deirdre Meldrum, Arizona State University
           Clark Miller, Arizona State University
           Dietram Scheufele, University of Wisconsin, Madison
           Jan Youtie, Georgia Institute of Technology

Annual Report for the Period
September 1, 2013 to August 31, 2014

This report includes work conducted at three collaborating universities of NSEC/CNS-ASU: Arizona State University, Georgia Institute of Technology, and the University of Wisconsin-Madison.
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3. Project Summary

The Nanoscale Science and Engineering Center/Center for Nanotechnology in Society at Arizona State University (NSEC/CNS-ASU) combines research, training, and engagement to develop a new approach to governing emerging nanotechnologies. CNS-ASU uses the research methods of “real-time technology assessment” to enable a strategic vision of anticipatory governance through enhanced foresight capabilities, engagement with lay publics, and integration of social science and humanistic work with nanoscale science and engineering research and education.

CNS-ASU has two types of integrated research programs, as well as educational and outreach activities (themselves well-integrated with research). Its real-time technology assessment programs are: RTTA 1, Research and Innovation Systems Assessment, which uses bibliometric and patent analyses to understand the evolving dynamics of the NSE enterprise; RTTA 2, Public Opinion and Values, which uses surveys and quasi-experimental media studies to understand changing public and scientists’ perspectives on NSE; RTTA 3, Anticipation and Deliberation, which uses scenario development and other techniques to foster deliberation on plausible NSE applications; and RTTA 4, Reflexivity and Integration, which uses participant-observation and other techniques to assess the Center’s influence on reflexivity among NSE collaborators. Second, the thematic research clusters (TRCs), which pursue fundamental knowledge and create linkages across the RTTAs, are: TRC 1, Equity, Equality and Responsibility; and TRC 2, Urban Design, Materials, and the Built Environment (“Nano and the City”).

The Center’s major conceptual-level achievements have been validating anticipatory governance as a richly generative strategic vision and advancing the related agenda of responsible innovation. Its major operations-level achievements include: 1) demonstrating capacities for foresight, engagement, and integration that constitute anticipatory governance; 2) completing the “end-to-end” activities by linking multiple RTTA capacities for (the earlier) TRC 2 to create novel insights in a study of nanotechnology and the brain and for TRC 1 to create novel insights into equity and nanotechnology; 3) deepening the integration of NSE researchers into CNS-ASU; and 4) building collaborations for informal science education (ISE) on the societal aspects of NSE. Programmatic achievements in the reporting year include: developing a new patent-mapping system based on patent citations; developing real-time insight into social media communication around nanotechnology; conducting a new type of future-oriented deliberation at scale; fielding a major study of CNS-ASU participants; developing a program to train scientists and engineers in engaging with the developing world; and creating compelling visual scenarios of Phoenix in 2050 as a nano-enhanced city.

The Center’s principal intellectual merit derives from the large-scale, interdisciplinary ensemble that underpins it. The ability to generate creative scholarship, embrace and facilitate interactions among disparate approaches to understanding nanotechnologies, and build complementary capacities to tap that knowledge for governance, is the critical intellectual contribution to which CNS-ASU aspires. The Center’s work has a substantial impact on scholarship, not only in terms of publications and citations but also through hosting international visitors. For broader impact, the Center has coupled research, education, and outreach activities exceptionally well by training significant numbers of new scholars from the social sciences and NSE, incorporating forefront research into a new winter school for early career scholars, new courses and ISE opportunities, and returning lessons learned and techniques developed for outreach back to the classroom. The Center has broadened the participation of under-represented groups by cultivating junior scholarship and raising issues of equity, gender, and disability as objects of programmatic study. The Center has enhanced the infrastructure for research and education by leading the creation of a new journal,
organizing community-defining conferences, producing community-defining sources of knowledge, serving as an international hub for scores of scholars, sharing data and instruments widely, and disseminating its results aggressively to its academic peers as well as to public, scientific, industry, and policy audiences through traditional means and increasingly through new media.
### 4. List of Center Participants, Advisory Boards, and Participating Institutions

#### 4. (a) LIST OF CENTER PARTICIPANTS

Participants receiving Center support:

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**Participant**

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Travis Johnson  Scientist  Agilent Technologies
Kevin Jones  Univ. of Alberta, Acting Dir. Research Fellow
Arlena Jung  Research Fellow  Research Center Berlin
Michele Kadnar  Associate Professor, English  National Institutes of Health
Dan M. Kahan  Cal., San Diego, Director
Seth Kahn  NASA, Senior Policy Advisor
Michael Kalichman  Officer of the Chief Scientist
Amy Kaminski  Participating
Chernor Kantora  Sr. Sci. & Inn. Policy Advisor  West Chester Pennsylvania
Brad Keelor  New Hampshire, Professor
Thomas Kelly  Acting Dir. Resource Economics/Environ. Sociology
Denisa Kera  Founder and President  National University of Singapore
George Khushf  Bergen, Research Fellow  QuantTera
Matt Kim  Director Ethics & Science in Technology
Tammy Kinsey  President  Film
Kamilla Kjolberg  Univ. South Carolina, Dir.
Frederick Klaessig  Associate Professor  National University of Singapore
Ralph Klavans  Manager  Center for Bioethics
Richard Kleinman  President  Pennsylvania Bio Nano Systems LLC.
Mark Knell  Wisconson, Professor  SciTech Strategies Inc.
Joan Koerber-Walker  Founder and President of the Chief Scientist
Kathy Kolbe  Norwegian Institute  Arizona Bioindustry Association
Kornelia Konrad  Pres. & Chief Exec. Officer  Nagoya University
Margaret Kosal  Assistant Professor  Arizona Bioindustry Association
Philip Kosar  GA Tech, Asst. Professor  Science, Technology, & Policy Studies
Fred Kronz  Prog. Dir., Sci., Tech. & Soc.  National Science Foundation
Kris Kulinowki  Research Staff Member  Science & Technology Policy Institute
Elizabeth K. Kullman  Sen. Res. & Eval. Associate  Museum of Science, Boston
Ray Kurzweil  California-Berkeley  Kolbe Corp.
Frank Kusiak  Chairperson  Science, Technology, & Policy Studies
Jennifer Kuzma  Minnnesota, Assoc. Professor  International Strategy, Technology & Policy
Kathy Kolbe  Norwegian Univ. Sci. & Tech.  National Science Foundation
Astrid Lagreid  Colorado, Professor  Science & Technology Policy Institute
Frank Laird  Tenn. State Univ., Professor  Museum of Science, Boston
Lewis Laska  Dir. of Econ. Develop.  Science Museum of Minnesota
Ruth Lee  Director  Electrical & Computer Engineering
Christopher Lenhardt  U-T Battelle, DAAC Sci. Lead  Electrical Engineering & Computer Science
Sam Lipson  Director of Envir. Health  Science & Technology Policy Institute
Laurie Locascio  Chief, Biochemical Sci. Div.  Natl. Inst. of Standards & Technology
Stephanie Long  Cornell, Professor  Science Museum of Minnesota
Brandon Lucas  Professor  Electrical Engineering & Computer Science
Michael Lynch  Dir. of Economic Develop.  Science & Technology Policy Institute
Christine MacKay  Durham University, Professor  Chandler City Government
Phil Macnaghten  Virginia Tech, Director  Geography
Roop Mahajan  Dir. of Econ. Develop.  Critical Technology & Applied Science
Farzad Mahootian  New York Univ., Professor  Global Liberal Studies
Jim Malone  Physician  Private Practice
Mike Manasco  Project Manager  Heliae
Brandon Lucas  Penn State, Dir. of Operations  NNIN Materials Research Institute
William Mansfield  Sr. V.P. Science Learning  Science Museum of Minnesota
Paul Martin  Wisconsin, Asst. Fac. Assoc.  Engineering Professional Development
Christina Matta  Participating

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<tr>
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Chief Scientist
Osher Lifelong Learning
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University of Central Florida
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Partner
Indiana, Professor
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Univ. of Seville, Professor
California, Berkeley, Prof.
Senior Research Scientist
Loka Institute, Staff
Sr. Mediator & Prog. Mgr.
Manchester, Sr. Res. Fellow
Participant
Jersey City, N.J.
Participant
S.I.W.S. N.R. Swamy College
Oregon Museum of Science & Industry
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Purdue University
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<td>Jan Youtie</td>
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Chakanaka Zinyemba  Mapping & Planning Support  Social Geographer
Lee Zwanziger  Designated Federal Official  Food & Drug Administration
Steven Zylstra  Pres. & Chief Exec. Officer  Arizona Technology Council

ASU

Post-Doctoral Scholars
Troy Benn  Post-doctoral Fellow  Civil & Environmental Engineering
Doe Daughtrey  Post-doctoral Fellow  Religious Studies
Hsiang-Kai D. Dong  Post-doctoral Fellow  Organizational Research & Design
Michael Fisher  Post-doctoral Fellow  Biodesign Institute
Rider Foley  Post-doctoral Fellow  Sustainability
Daniel Higgins  Post-doctoral Fellow  Center for Nanotechnology in Society
Punarvasu Joshi  Post-doctoral Fellow  Elect. Comptr. & Energy Engineering
Anastasios Panaretos  Post-doctoral Fellow  Electrical Engineering
Kiera Reifschneider  Post-doctoral Fellow  National Nano. Infrastructure Network
Michael Reinsborough  Post-doctoral Fellow  Center for Nanotechnology in Society
Cathy Slade  Post-doctoral Fellow  Public Policy
Olgica Trenchevska  Post-doctoral Fellow  Biodesign Institute
Walter Valdivia  Post-doctoral Fellow  Public Administration
Kathryn Vignone  Post-doctoral Fellow  Center for Nanotechnology in Society
Berea Williams  Post-doctoral Fellow  Chemistry & Biochemistry

ASU

Graduate Researchers
Dulce Perez Aguilera  Social Justice
Parul Agrawal  Materials Science & Engineering
Rebecca Allen  Biodesign Institute
Carlo Altamirano-Allende  Human and Social Dimensions of S & T
Judd Anderman  Science & Technology Policy
Caroline Appleton  Biology & Society
Ebraheem Azhar  Electrical Engineering
Marci Baranski  Biology & Society
Ceyhan Beckham  Electrical Engineering
Michael Bernstein  Sustainability
Monamie Bhadra  Human & Social Dimensions of S & T
Shreya Bhattacharyya  Chemistry & Biochemistry
Bradley Brennan  Biology & Society
Jennifer Brian  Electrical Engineering
Miles Brundage  Human & Social Dimensions of S & T
Michael Burnam-Fink  Human & Social Dimensions of S & T
Andrew Candelaria  Nanoscience
Melissa Cannon  Science and Technology Policy
Angela Cazel-Jahn  Sustainable Solutions
Santhosh Chenna  Engineering of Matter, Transport & Energy
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William Lepkowski  
Shannon Lidberg  
Jewel Loree  
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Engineering  
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Curriculum & Instruction (Engineering)  
Biology  
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Biophysics  
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PSM Nanoscience  
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Yi Lai Christine Luk
Christopher Madden
Kevin Margeson
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Mechanical Engineering
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Applied Mathematics for Life & SocSc
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Urban & Environmental Planning
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Science, Technology & Ethics
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Chemistry & Biochemistry
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Public Policy
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Jonathan Huang  Georgia Tech
Lu Huang  Beijing Institute of Tech.
Jennifer Jensch  Wisconsin
Ronak Kamdar  Georgia Tech
Maria Karaulova  University of Manchester
Megan Kierstead  Massachusetts Amherst
Byoungyoon Kim  Rensselaer Poly. Institute
Enukyung Kim  Wisconsin
Jiyoun Kim  Wisconsin
Sojung Kim  Wisconsin
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Brice Laurent  Ecole des Mines
Ricky Leung  Wisconsin
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Nan Li  Wisconsin
Yin Li  Wisconsin
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Miao Liao  Wisconsin
Monica List  Tsinghua University
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Yan Liu  Georgia Tech
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TingTing Ma  University of Twente
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Christopher Palmer  North Carolina State Univ.
Krishna Parthasaathi  Georgia Tech
Jayesh Patil  M.Sc. in Public Policy
Ruimin Pei  Chinese Academy of Science
Elizabeth Pitts  Communication, Rhetoric & Digital Media
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<td>Dena Plemmons</td>
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<td>Maria Stubbings</td>
<td>Wisconsin</td>
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<tr>
<td>Leona Yi-Fan Su</td>
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<td>Vrishali Subramanian</td>
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<td>Meghnaa Tallapragada</td>
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<td>Francois Thoreau</td>
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<td><strong>Roberto Toledo</strong></td>
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<td>Rutger van Merkerk</td>
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<td>M. Van Oudheusden</td>
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<td>Charles Walsh</td>
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<tr>
<td>Wening Wang</td>
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<td>Alec Waterworth</td>
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<td>Rosalyna Wijaya</td>
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<td>John Willingham</td>
<td>North Carolina State</td>
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<td><strong>Thomas Woodson</strong></td>
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<tr>
<td>Xuanting Ye</td>
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<td><strong>Sara Yeo</strong></td>
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<tr>
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<tr>
<td>Qin Zhu</td>
<td>Purdue University</td>
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**ASU**

**Undergrad Interns & Researchers**

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<thead>
<tr>
<th>Name</th>
<th>Field</th>
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<tbody>
<tr>
<td>Krizia Alba</td>
<td>Graphic Design</td>
</tr>
<tr>
<td>Kalil Abdullah</td>
<td>Molecular Biotechnology</td>
</tr>
<tr>
<td>Eric Beeler</td>
<td>Sustainability</td>
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</table>
Nidhi Bhalla  
Nolan Bidese  
Brandon Borsheim  
William Bowman  
Linda Boyd  
Tanner Brants  
Robert Bui  
Connie Burdis  
Geoffrey Byers  
David Calderon  
Ricky Carmago  
Wyatt Chafin  
Rahul Chhabra  
Josh Choi  
Kelley Conley  
Aaron Cornejo  
Amie Dabu  
Rob Davis  
Kendall Denike  
Emilie Doering  
Daniel Dykas  
David Edwards  
Tara Egnatios  
Daniel Escolin  
Alicia Fremling  
Tereza Fritz  
Andrew Gaddis  
Ian Griffith  
Alexandria High  
Hannah Hall  
Catherine Hoke  
Sarah Hoke  
Rebecca Hudson  
Joleen Jansen  
Thomas Kajder  
David Kreie  
Dania Lopez  
Benjamin Lowenstein  
Rachel Lowenstein  
Alexander MacLean  
Keith Martin  
Colin McDonald-Smith  
Tobie Milford  
Timothy Norris  
Sidra Omer  
Girish Pathangey  
Mark Petersen  
Zachary Pirtle  
Jaron Reed  
David Renolds  
Lucas Rogers  

Political Science  
Biomedical Engineering  
Sustainability  
Materials Science & Engineering  
Geography  
Management  
Electrical Engineering  
Supply Chain Management  
Business Tourism/Management  
Molecular Bioscience & Biotechnology  
Marketing/Management  
Marketing  
Chemistry  
Biomedical Engineering & Economics  
Psychology  
Biomedical Engineering  
Sustainability  
Biology  
Industrial Design  
Global Studies  
Industrial Design  
English & Creative Writing  
Public Policy  
Film and Media Production  
Management, Political Science, Spanish  
Global Studies  
Industrial Engineering  
Film & Media Studies  
Business  
Sustainability  
Mechanical Engineering  
Asian Language  
Business  
Industrial Design  
Computer Science  
Graphic Design  
Biochemistry  
Sociology  
Business  
Honors  
Film  
Computer Science  
Biology & Society  
Architectural Studies  
Journalism & Mass Communication  
Biomedical Engineering  
Economics  
Mechanical Engineering  
Political Science  
Chemical Engineering  
Engineering
Dusana Schnell-Vivas  Marketing
Jesse Shedd  Anthropology
Suzanne Shlom  Design Studies
Rachel Smith  Biology & Society
Chad Stearns  Economics
Evan Taylor  Sustainability
Jonah Thomas  Biomedical Engineering
Duncan Thomason  Graphic Design
Clelia Tommi  Earth Space Exploration
Daryl Traylor  Microbiology
Xavier Vargas  Mechanical Engineering
Kaitlin Vortherms  Civil Engineering (Envir. Engin.)
Tai Wallace  Sustainability
Amelia Walsh  Interdisciplinary Studies
Julia Weakley  Global Studies
Brian Young  Biology & Society
Ke Wu  Biology & Society

Affiliated Undergrad Interns & Researchers
Annie Bidgood  Georgia Tech
Audrey Campbell  Georgia Tech
Brescia Cassellius  Wisconsin
Gordon Cutler  Georgia Tech
Sharyn Finney  Georgia Tech
Brian Lynch  Georgia Tech
John Garner  Georgia Tech
Clay Karwisch  Georgia Tech
Charles Luke McCloud  Georgia Tech
JJ O’Brien  Georgia Tech
Laura Rodriguez  Georgia Tech
Dave Schoeneck  Georgia Tech
Shawn Skolky  Georgia Tech
Charles Walsh  Wisconsin

CNS-ASU Staff
Deron Ash  Program Manager
Jennifer Banks  Program Coordinator
Melissa Cornish  Program Coordinator
Elizabeth Curran  Program Coordinator
Corrine Dillon  Program Coordinator
Daniel Hooker  Program Coordinator
Michelle Iafrat  Program Coordinator
Regina Sanborn  Assistant Director
Joy Trotter  Administrative Associate

Participants affiliated, not receiving CNS-ASU support:

ASU
Kenneth Abbott  Professor  Law
Azadeh Adibi  Graduate Student  Industrial Design
Luis Aguilera  Student
Francisca Agusta  Student
Ismeeel Almarazeeq  Graduate Student
Mohamed Alqabandy  Graduate Student
G. Alvarez Sieber  Professor
Ariel Anbar  Retired Faculty
Sandra Andrews  Communications Coordinator
Catherine Arnold  Professor
Jose Ashford  Student
Heman Au  Graduate Student
James Audiss  Graduate Student
Ricardo Avila  Student
Denise Baker  Graduate Student
John Ball  Graduate Student
Carl Ballard  Graduate Student
Sasha Barab  Professor
Maribel Barba  Wed Designer/Developer
Anna Barker  Director
Michelle Barry  Graduate Research Associate
Tain Barzso  Instructional Tech. Analyst
Jennifer Bekki  Doctoral Student
Leslie Beres  Director College Facility
Zachariah Berkson  Student
Vineet Bhosle  Graduate Student
Jordan Biechler  Student
Colleen Bivona  Program Manager
James Blasingame  Associate Professor
Thomas Bleasdale  Graduate Student
Timur Boskailo  Student
Rachel Bowditch  Assistant Professor
Amanda Breaux  Events Coordinator
Nicholas Broderick  Student
Daniel Brune  Faculty Research Associate
Banel Bucknor  Student
Caren Burgermeister  Project Coordinator
Winslow Burleson  Assistant Professor
Daragh Byrne  Assistant Research Professor
David Calverley  Attorney
Joel Carrasco  Graduate Student
Angela Cazel-Jahn  Artist/Graduate Student
M. Chavez-Echeagaray  Graduate Student
Jeffrey Chudy  Student
Sam Chung  Faculty
Daniel Cifuentes  Graduate Student
Jeffrey Clancy  Graduate Student
Robert Clinton  Professor
Grisha Coleman  Assistant Professor
David Corral  Student
Jacqueline Cortez  Graduate Student
Michael Crow  President
Roy Curtiss  Professor

Director
Graduate Research Associate
Instructional Tech. Analyst
Doctoral Student
Director College Facility
Student
Graduate Student
Student
Program Manager

Transformative Healthcare Networks
Sustain. Engr. & Built Envir.
Digital Culture
Industrial Engineering
Design & Arts
Chemical Engineering
Architecture
Explore-Social & Behavioral Sci.
Arts Media & Engineering
English

Environmental Social Sciences
Architectural Studies
Theatre & Film
Law
Theatre & Film
Life Sciences
Design
Computing & Informatics
Arts Media & Engineering
Law, Science and Technology
Landscape Architecture
Humanities Research
Computer Science
Art Exploratory
Art (Ceramics)
Arch. & Urban Design
Architecture
Law
Arts Media & Engineering
Civil Engineering
Architecture
Arizona State University
Biodesign Institute
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Department</th>
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<tbody>
<tr>
<td>Daniel Cutrara</td>
<td>Assistant Professor</td>
<td>English</td>
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<tr>
<td>Williams Dabars</td>
<td>Dir. Special Communications</td>
<td>Office of Public Affairs</td>
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<tr>
<td>Peter de Marneffe</td>
<td>Professor</td>
<td>Historical, Philosophical &amp; Religious Stud.</td>
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<tr>
<td>S. Doddaballapur</td>
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<td>Urban Design &amp; Built. Environ.</td>
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<tr>
<td>Heather Draper</td>
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<td>Michelle Duah</td>
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<td>Mark Dudlik</td>
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<td>Margaret Duff</td>
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<tr>
<td>Lauren Dykes</td>
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<td>Joel Greene</td>
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</table>
Hilary Harp  Assistant Professor  Art
Thomas Hartman  Associate Professor  Design
Lee Hartwell  Professor  EVPP Consultant Group
Elisabeth Hayes  Professor  English
Stephen Hermens  Student  Chemical Engineering
Colin Ho  Student  Mechanical Engineering
Jenna Hoban  Student  Biomedical Engineering
Kim Holsclaw  Graduate Student  Dir. of Programs-Solutions
Janet Holston  Professor  Design

Christiana Honsberg  Professor  Engineering
Timothy Horn  Graduate Teaching Assistant  Education Outreach & Student Svcs.
Afzal Hossain  Manager Creative Services  Design & Arts
Sarah Hough  Graduate Student  Design

Amelia Huggins  Mgr. Marketing & Comm.  LightWorks
A Magdalena Hurtado  Professor  Human Evolution & Social Change
Zahra Hussaini  Student  Materials Science & Engineering
Joanna Iacovelli  Graduate Teaching Assistant  Foundation
Jeffrey Ignaszewski  Professor & Director  Design & Arts
Todd Ingalls  Student  Arts Media & Engineering

Aziza Ismael  Student  CSPO
Courtney Jackson  Retired Faculty  Architecture
Jane Jackson  Communications Cordinator  Arts Media & Engineering
Jennifer Jacekals  Specialist to Director  Design & Production
Erin Jeffries  Professor  Physics

Adriene Jenik  Graduate Research Associate  Elect. Comptr. & Energy Engineering
Jeff Jilek  Student  Theatre & Film
Parker Jones  Graduate Teaching Assistant  Theatre & Film
Joseph Jurado  Professor  Theatre & Film
Korhan Kaftanoglu  Project Manager  Theatre & Film
Michael Katic  Student  Film
Josh Katzker  Assistant Professor  Theatre & Film

Braden Kay  Graduate Teaching Assistant  Theatre & Film
Anita Keitel  Professor  Earth and Space Exploration
James Keller  Student  Sustainability
Aisling Kelliher  Graduate Teaching Assistant  Sustainability

Amruta Khanolkar  Professor  Sustainability
Heather Kaftanoglu  Student  Sustainability
Michael Katic  Graduate Teaching Assistant  Sustainability

Daniel Kharisma  Student  Sustainability
Sydney Lines  Graduate Teaching Assistant  Sustainability

Sheri Klug Boonstra  Associate Research Profess.  Sustainability
Dhara Kothavala  Student  Sustainability
Matthew Krise  Graduate Teaching Assistant  Sustainability
Michael Kroelinger  Professor  Sustainability

Nicholas Kunz  Student  Sustainability
Michael Lande  Graduate Teaching Assistant  Sustainability
Heather Landes  Student  Sustainability
Heather Le Fur  Student  Sustainability
Neal Lester  Student  Sustainability
Tyler Libey  Student  Sustainability
Min Lin  Student  Sustainability
Heather Lineberry  Interim Associate Director  Sustainability
Sydney Lines  Management Intern  Sustainability
Priscilla Long
Lauren Loosveldt
Richard Loveless
Ryan Luikens
Jane Magruder
Giada Mannino
Jingzian Mao
Erik Margolis
Richard Martorano
**Carolyn Mattick**
Maritza Maurer
Michael McBeath
Scott McClintock
Danielle McNamara
Michael Meeder
Deirdre Meldrum
George Moakley
Erika Mohaupt
Adam Monroe
Gabriel Montemayor
Michael Montgomery
Scott Murphy
Rafiu Mustapha
Michele Mutchek
Anumeha Narain
Spencer Nelson
Judy Newland
**Nils Newman**
Judy Nichols
Juliana Novic
Lindsey O’Connell
Prescott Ogden
Grace O’Sullivan
Daniel Oliden
Paul Oran
Victor Orioke
Larry Orr
Suzan Ozcelik
Michael Pang
Mookesh Patel
Varun Patel
Peggy Payne
Chi-Han Peng
Jacob Pinholster
Vincent Pizziconi
Evan Pomerantz
Carlan Pontious
Randal Pope
**Linda Raish**
Adriana Ramos
Patricia Reiter

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<tr>
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<tbody>
<tr>
<td>Student</td>
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<tr>
<td>Emeritus Professor</td>
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<tr>
<td>Dir. Print Comm. &amp; Med. Rel. Graphic Designer</td>
<td>Graduate Student</td>
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<tr>
<td>Associate Professor</td>
<td>Director</td>
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<td>Graduate Student</td>
<td>Support Systems Analyst</td>
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<tr>
<td>Professor</td>
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<td>Manager</td>
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<td>Associate Professor</td>
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<tr>
<td>School Dir. &amp; Assoc. Prof.</td>
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Sustainable Engrg. & Built Environment
Design & Arts
Psychology
Sustainability
Learning Sciences Institute
English
Fulton School of Engineering
Theatre & Film
Design
Chemistry & Biochemistry
Arch. & Landscape Arch.
Psychology
Technology
Engineering
Sustainability
Industrial Design
Design Studies
Anthropology
Intelligent Info. Services Group
Law
Anthropology
Bio and Society
Electrical Engineering
Biodesign Institute
Sustain. & the Built Environment
Biodesign Institute
Biomedical Engineering
Chemistry & Biochemistry
Urban Design & Architecture
Law
Visual Communication Design
Biomedical Engineering
Law
Computer Science
Theatre & Film
Bioengineering
Art
Industrial Design
GRES
Development
Urban Design
Sustainability
Wellington Reiter Special Advisor to President Arizona State University
Deborah Relph Program Coordinator Law
Grant Richardson Student
Thanassis Rikakis Vice Provost of Design Student
Mindy Robbins Office Specialist Sr.
Laura Rodriguez Graduate Student
Susan Rubin Events Coordinator Sr.
Shaily Rungta Graduate Student
Richard Rushforth Graduate Student
Julie Russ Coordinator Senior
Michael Russo Graduate Student
Justin Ryan Graduate Student
Arthur Sabatini Associate Professor
Michael Saks Student
Jamie Sandomire Graduate Teaching Assistant
Deepika Sangoi Graduate Student
Lisa Santy Student
Blaire Schenck Librarian
Sherrie Schmidt Graduate Teaching Assistant
Sara Schwabe Graduate Teaching Assistant
Samantha Sears Graduate Teaching Assistant
Allison Shannon Graduate Teaching Assistant
Ankur R. Sharma Student
Nicholas Shekerjian Vice Provost
Denis Simon Librarian
Vipul Singh Graduate Research Assistant
Ian Smith Student
Bryan Smith Professor
Michael E. Smith Professor
Milton Sommerfield Professor
Alexandra Spaeth Professor
Andreas Spanias Professor
Anton Spevacek Manager Information Tech.
Joseph Spiro Graduate Student
Jim St. Leger Technology Marketing Mgr.
Ellen Stechel Deputy Director & Professor
Anne Stone Professor
Jason Sutlut Professor
Hari Sundaram Professor
Douglas Sylvester Interim Dean
Christine Szuter Professor of Practice
Chen Tang Graduate Student
Michael Thomet Graduate Student
Michael Thompson Student
Leslie Thornton Assistant Professor
Ben Tieni Student
Paulette Tohonnie Student
Lisa Tolentino Graduate Student
Jose Torres Student
Pavan Turaga Assistant Professor

Arizona State University
Law
Graphic Design
Arts, Media and Engineering
Architectural Studies
College of Technology & Innovation
Sustainability
Built Environment

Sustainability
Institute of Human Origin
Architecture
Bio. & Health Systems Engin.
Humanities Arts & Culture
Law
Theatre & Film
Arch. & Landscape Arch.
Landscape Architecture
Interior Design
Hayden Library
Theatre & Film
Arch. & Landscape Arch.
Sustainability
Electrical Engineering
Architectural Studies
China Initiatives and Strategy
Built Environment
Technology Based Learning Res.
Interdisciplinary Studies
Sustainability
Hum. Evol. & Social Change
Life Sciences
Bio Science
Computer Science
Intel
LightWorks
Hum. Evol. & Social Change
Applied Ethics
Arts, Media & Engineering
Law
Hist., Phil. & Religious Studies
Industrial Design
English
Theatre & Film
Journalism & Mass Comm.
Graphic Design
Interior Design
Media Arts & Sciences
Landscape Architecture
Arts Media & Engineering
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<tbody>
<tr>
<td>Steven Turner</td>
<td>Student Business &amp; Management</td>
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<tr>
<td>Diane Van Hoy</td>
<td>Student Aerospace Engineering</td>
</tr>
<tr>
<td>Arvin Villena</td>
<td>Student Explore-Health/Life Sciences</td>
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<tr>
<td>David Wahls</td>
<td>Regional Major Gift Officer</td>
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<tr>
<td>Sheila Wakelam</td>
<td>Graduate Student</td>
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<td>Matt Watkins</td>
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Hardware Engineer
Designer
Mus. of Life Science, Director
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Participant
Participant
Systems Administrator
Public Policy
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Science & Technology Studies
City Manager
Staff
Manager, Adult Services Dept.
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Participant
Assistant Professor
Member
Director
Federal University of Parana
Director, Natl. Collab. Proj.
Indep. Mgmt. Consultant
Computer Science & Engin.
Writer / Editor
Dean, Institutional Planning
Planning Department
Participant
Participant
Postdoctoral Scholar
Global Studies
Artist/Craftsman
Participant
Member
Student
Senior Consultant
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Systemist  
Graduate Student  
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Instructor  
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Anita Yap  Community Advocate  Beijing Institute of Technology
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Richard Freedman  Harvard University
Barbara Harthorn  UCSB
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Maxwell J. Mehlman  Professor  Case Western Reserve
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Jason S. Robert  Assistant Professor  ASU
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Ida Andersen, Danish Board of Technology
David Rejeski, Director, Project on Emerging Nanotechnologies, Woodrow Wilson International Center for Scholars
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Arizona Technology Enterprises (AzTE)
Axon Technologies
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Biodesign Institute
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Center for Research on Education in Science, Mathematics, Engineering, & Technology (CRESMET)
Center for the Study of Religion & Conflict
Center for Law, Science and Innovation
Center for Science and the Imagination
Center for Solid State Electronics Research
Center for Study of Institutional Diversity
College of Liberal Arts & Sciences
College of Public Programs
College of Technology & Innovation
Complex Adaptive Systems Initiative
Consortium for Science, Policy & Outcomes
Cyberinfrastructure Services
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Office of China Initiatives and Strategy
Office of Knowledge and Enterprise Development (OKED)
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Office of the President
Office of the Vice President and Provost
Office of University Initiatives
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Phoenix Urban Research Laboratory
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Sandra Day O’Connor School of Law
School of Earth & Space Exploration
School of Government, Politics, & Global Studies
School of Human Evolution & Social Change
School of International Languages & Cultures
School of Letters & Sciences  
School of Life Sciences  
School of Mathematical & Statistical Sciences  
School of Philosophical, Historical, and Religious Studies  
School of Social Transformation  
School of Sustainability  
Science Policy Assessment & Research on Climate (SPARC)  
Stardust Center  
Technology Based Learning Research  
Transformative Healthcare Networks  
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Ecole des Mines, France  
ETH Zurich  
Eugene Lang College the New School for Liberal Arts
Ewha Women’s University
Federal University of Parana, Brazil
Federal University of Santa Catarina, Brazil
Flemish Institute of Science & Technology
Florida International University
George Mason University
George Washington University
Georgetown University
Georgia Institute of Technology
Glendale Community College
Grenoble Institute of Technology
Grove City College
Harvard University
Howard University
Illinois Institute of Technology
Indiana University
Institute of International Sociology of Gorizia
Institut d’Etudes Politiques de Grenoble, France
Iowa State University
James Martin Institute for Science & Civilization, Oxford University, UK
Johns Hopkins University
Karlsruhe Institute of Technology
Keele University
Korea Institute of Science and Technology, Seoul, Korea
Lancaster University, UK
Leeds University Business School, UK
Lehigh University
Litchfield Elementary School District
Long Island University
Macalester College
Manchester Business School
Maricopa Community Colleges
McGill University
Mesa Biotech Academy
Mesa Community College
Mesa High School
Michigan State University
MIT SENSEable City Lab
Montana State University
Nagoya University, Japan
National Academy of Sciences
National University of Singapore & Asia
New York University
North Carolina State University
Northeastern University
Northern Alberta Institute of Technology
Northwestern University
Norwegian University of Science & Technology, Norway
NSEC/CNS-University of California, Santa Barbara (UCSB)
Ohio State University
Osaka University, Japan
Pennsylvania State University
Plymouth University
Portland State University
Purdue University
Queens University
Radboud University
Rensselaer Polytechnic Institute
Rhode Island School of Design
Rice University
Rice University/ICON
Rio Salado College
Rochester Institute of Technology
Roger L. Putnam Vocational Technical Academy
Rutgers, The State University of New Jersey
RWTH Aachen University
Said Business School, Oxford
Sapienza University of Rome
Scottsdale Community College
Simon Fraser University, British Columbia
S.I.W.S. N.R. Swamy College, India
South Mountain Community College
Stanford University
State University of Campinas
Stony Brook University
Tamkang University
Technical University of Delft
Technical University of Denmark
Technical University of Darmstadt
Tennessee State University
Texas State University, San Marcos
The Center for International Development, Harvard University
Tokyo University
Tsinghua University, China
UCLA/Harvard/NBER: Collaborative Research; Personnel Exchanges
UMC St. Radboud
Unicamp University, Brazil
Universidad de Zacatecas, Mexico
Universidad del Pais Vasco, Spain
Universita Ca’ Foscari Venezia
University College London
University at Albany
University of Alberta
University of Amsterdam
University of Antwerp, Belgium
University of Arizona
University of Athens
University of Basel
University of Basque Country
University of Bergen, Norway
University of Bielefeld, Germany
University of British Columbia
University of Calgary, Canada
University of California, Berkeley
University of California, Davis
University of California, Irvine
University of California, Los Angeles
University of California, San Diego
University of California, Santa Barbara
University of Cape Town
University of Central Florida
University of Chicago
University of Colorado, Boulder
University of Colorado, Denver
University of Copenhagen
University of Denver
University of Edinburgh
University of Exeter, United Kingdom
University of Florida
University of Geneva
University of Georgia
University of Gothenburg, Sweden
University of Groningen, Netherlands
University of Illinois, Chicago
University of Illinois, Springfield
University of Illinois, Urbana-Champaign
University of Iowa
University of Jiangsu, China
University of Lausanne, Switzerland
University of Leeds
University of Liege, Belgium
University of Manchester, United Kingdom
University of Maryland
University of Massachusetts, Amherst
University of Melbourne, Australia
University of Michigan
University of Minnesota
University of Montana
University of Nebraska, Lincoln
University of Nevada, Las Vegas
University of New Hampshire
University of New South Wales, Australia
University of North Carolina, Chapel Hill
University of North Carolina, Charlotte
University of North Texas
University of Notre Dame
University of Nottingham
University of Oslo
University of Oxford
University of Padua
University of Seville, Spain
University of South Carolina
University of South Florida
University of Southern California
University of Southern Indiana
University of Sussex, United Kingdom
University of Tennessee, Knoxville
University of Texas, Austin
University of Trieste, Italy
University of Twente, the Netherlands
University of Turku
University of Utah
University of Victoria
University of Vienna
University of Virginia
University of Washington
University of Waterloo
University of Wisconsin, Madison
UT-Battelle
Utrecht University
Vanderbilt University
Villanova University
Virginia Polytechnic Institute & State University
Virginia Tech University
VU University of Amsterdam
Washington University, Saint Louis
West Chester University of Pennsylvania
Western Michigan University
Yale University
York University
4. (d) Non-Academic Participating Institutions

Agilent Technologies
Airplayn
Alberta Centre for Advanced Micro Nano Technology Products
Alberta Innovates Technology Futures
ALD Nano Solutions
Alsek Research
American Association for the Advancement of Science (AAAS)
American Bar Foundation
Apriva ISS
Arizona Bioindustry Organization
Arizona Commerce Authority
Arizona Corporation Commission
Arizona Department of Education
Arizona Department of Health Services
Arizona Nanotechnology Cluster
Arizona Public Service (APS)
Arizona Research Institute for Solar Energy
Arizona Science Center
Arizona Technology Council
Army Military Command
Australian Government
Bank of America
Bassetti Foundation
Bioindustry Organization of Southern Arizona
Boudreaux and Associates
BrasEq
Brilliant Concepts LLC.
British Embassy
Brookings Institute
Buckeye Express
Burton Barr Central Library
Cambridge Public Health Department
Carnegie Mellon
CB Richard Ellis
CEA-Saclay
Cell Publishing
Center for Business Models in Health Care
Center for Naval Analysis
Center for Responsible Nanotechnology
Changeist, LLC.
Chemical Heritage Foundation
Children’s Museum of Phoenix
City of Apache Junction
City of Edmonton
City of Phoenix
City of Scottsdale
Complex Global Risks
Corgan Associates
Council of Scientific and Industrial Research
Danish Board of Technology
David Crowley Gallery
Decker Yeadon LLC
Denise Meridith Consultants, Inc.
Department of Energy (DOE)
Department of the Treasury
Department of Transportation
Depave
Describe, LLC.
Desert Botanical Garden
Digital Thinking Network
Downtown Phoenix Journal
Ecological Society of America
EKLATEK Engineering
E.L. Smith Water Treatment Plant
Emerging Leaders in Science & Society (ELISS)
Engineering & Physical Sciences Research Council (EPSRC)
Environmental Protection Agency (EPA)
Equus Development Corporation
Eureka
European Commission
Exploratorium, San Francisco
Federal Aviation Administration Office of Environment & Energy
FBI Weapons of Mass Destruction
Food and Drug Administration (FDA)
Foundation for Genomics and Population Health
Gallagher and Kennedy
General Dynamics
Genøk Centre for Biosafety
Genome British Columbia
German Parliament
Global Business Network
Gould Evans
Gordon Research Conferences
Greenwall Foundation
Ground Work Portland
HafenCity University
HDR Architecture
Heatsync Labs
Heliae
Home Depot
Iconic Architecture
Ikologoi
INEREM
Institute for Agriculture and Trade Policy
Institute for Ecological Economy Research, Germany
Institute for the Future
Institute of Technical Assessment & Systems Analysis
Intel
Intelligent Information Services Corporation (IISC)
International Nanotechnology in Society Network (INSN)
International Research Center
Ira Domsky Environmental
Italian National Research Council, Turin, Italy
ITel
Ivy Consulting, Inc.
Jennings, Strouss, & Salmon PLC
Kaiser Permanente
Kolbe Corp.
Kristine Wilcox Consulting
Las Vegas-Clark County Library District
Lasertel, Inc.
Lawrence Livermore Lab
Leathers Milligan & Associates
Loka Institute
London Science Museum
Luxe Ventures
Lyman and Merrie Wood Museum of Springfield History
Mabelson Law Group
Mapping & Planning Support (M.A.P.S.) Alberta Capital Region
Max Chandler Robot Art
Mayer-Reed Architects
Mayo Clinic - Scottsdale
Meridian Institute
Metacurrency Project
Microchip
MJS Designs, Inc.
Modern Insights
Museum of Life & Science, North Carolina
Museum of Science, Boston
Nano-Alberta
Nanoscale Informal Science Education Network (NISENet)
National Academy of Engineering
National Advisory Committee on Aeronautics (NASA)
National Building Museum
National Business Museum
National Geographic Society
National Institute of Nanotechnology
National Institute of Standards and Technology (NIST)
National Institutes of Health (NIH)
National Nanomanufacturing Network (NNN)
National Nanotechnology Coordinating Office
National Nanotechnology Infrastructure Network
National Research Council
National Research Council of Canada
National Science Foundation
Nature.com
Nature Publishing Group
New Haven Independent
Norwegian Institute
Nothing but NET
NRG Energy, Inc.
Nuclear Waste Review Board
Office of Naval Research
Oregon Museum of Science & Industry (OMSI)
PACeHR
Penman PR
Pennsylvania Bio Nano Systems, LLC.
Phoenix Public Library
Phoenix Rising
Phoenix Spokes People
Phoenix Zoo
Physician Services Group
PING Inc.
Pioneer Valley Transit Authority
Planetary ONE
Portland Bureau of Environmental Services
Practical Action
Presidential Commission for the Study of Bioethical Issues
Quantiam Technologies Inc.
QuantTera
Rathenau Institute
RCI Surveys, Inc.
Research Center Berlin
Research Council of Norway
Research Councils U.K. (RCUK) in the U.S.
Re/Max Fine Properties
Research Media Ltd.
Richard + Bauer Architecture
Rockefeller Foundation
Rose Community Development Corporation
Rutgers and Posch
Ryley, Carlock & Applewhite Attorneys
Salt River Project
Sandia National Laboratory
Savage Film
Science and Technology Institute
Sciencenter, New York
Science Foundation Arizona
Science Museum of Minnesota
SciStarter
SciTech Strategies, Inc.
Scottsdale League for the Arts
Search Technology
Semi-Conductor Research Corporation
SETI Institute
Shannon and Wilson, Inc.
SmithGroup
Snell and Wilmer Law
Social Sciences and Humanities Research Council of Canada
Sokolov, Sokolov, Burgess Solutions (SSB)
South of Market EcoDistrict
Spirit of the Senses Salon
Springer Publishing
SRI International
Startup Edmonton
Strategic Advantage, Inc.
Sundt Construction, Inc.
Synthetic Biology Engineering Research Ctr. (SynBERC)
SySTEM Schools, Inc.
Targeted Genetics Corporation (TGen)
Teach America
TEC Edmonton
Televerde
Telus World of Science
Tempe Festival of the Arts
Testani Design Troupe, Inc.
The Elumenati, LLC
The Embryo Project
The Energy and Resources Institute
The Foresight Institute
The Galaxy Organization
The Geek Group of Western Massachusetts
The Rockefeller Foundation
The Royal Society
The Washington Post
Town Hall Education Arts Recreation Campus
Translational Genomics Research Institute (TGEN)
TraskBritt Intellectual
TRIMET Transportation
Underwood Bros., Inc.
Unicorn Media, Inc.
U.S. Government Accountability Office (U.S. GAO)
U.S. Green Building Council
U.S. Department of Agriculture
U.S. Department of Homeland Security
U.S. Department of Transportation
U.S. DOE/Center for Integrated Nanotechnology (CINT)
Venezuelan Institute for Scientific Research
Western Massachusetts Electric Company
Will Bruder & Partners Ltd.
Winnipeg Art Gallery
Woodrow Wilson International Center for Scholars
### 5. Quantifiable Outputs

#### Table 1: Quantifiable Outputs - NSF Award #0937591

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Reporting Year-1</th>
<th>Reporting Year-2</th>
<th>Reporting Year-3</th>
<th>Reporting Year-4</th>
<th>Reporting Year-5</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publications resulted from NSEC Support</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>in Peer Reviewed Journal</td>
<td>19</td>
<td>39</td>
<td>43</td>
<td>38</td>
<td>139</td>
<td></td>
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<tr>
<td>in Peer Reviewed Conference Proceedings</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>in Peer Reviewed Book Chapters</td>
<td>9</td>
<td>18</td>
<td>29</td>
<td>6</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Technical Reports</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Working Papers</td>
<td>7</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Books</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Theses</td>
<td>9</td>
<td>8</td>
<td>3</td>
<td>2</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>in Trade Journals</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Other Journal Publications</td>
<td>2</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Internet</td>
<td>17</td>
<td>11</td>
<td>16</td>
<td>10</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>with Multiple Authors</td>
<td>36</td>
<td>43</td>
<td>73</td>
<td>47</td>
<td>199</td>
<td></td>
</tr>
<tr>
<td>co-authored with NSEC faculty</td>
<td>34</td>
<td>43</td>
<td>72</td>
<td>11</td>
<td>160</td>
<td></td>
</tr>
</tbody>
</table>

| NSEC Technology Transfer | | | | | |
| Inventions Disclosed | 0 | 3 | 3 | 3 | 9 |
| Patents Filed | 0 | 0 | 0 | 0 | 0 |
| Patents Awarded | 0 | 0 | 0 | 0 | 0 |
| Software Licensed | 0 | 0 | 0 | 0 | 0 |
| Spin-off Companies Started | 0 | 0 | 0 | 0 | 0 |

| Degrees to NSEC Students | | | | |
| Bachelors Degrees Granted | 14 | 8 | 12 | 12 | 46 |
| Masters Degrees Granted | 12 | 11 | 9 | 10 | 42 |
| Doctoral Degrees Granted | 14 | 10 | 5 | 5 | 34 |

| NSEC Graduates Hired by | | | | |
| Industry | 12 | 15 | 3 | 10 | 40 |
| NSEC participating Firms | 0 | 0 | 0 | 0 | 0 |
| Other US Firms | 12 | 15 | 3 | 0 | 30 |
| Government | 3 | 2 | 2 | 0 | 7 |
| Academic Institutions | 15 | 12 | 3 | 4 | 34 |
| Other | 0 | 0 | 0 | 0 | 0 |
| Unknown | 10 | 0 | 18 | 13 | 41 |

| NSEC Influence on Curriculum | | | | |
| New Courses Based on NSEC Research | 4 | 7 | 1 | 1 | 13 |
| Courses Modified to Include NSEC Research | 0 | 0 | 0 | 2 | 2 |
| New Textbooks Based on NSEC Research | 0 | 0 | 0 | 0 | 0 |
| Free-standing Course Modules or Instructional CDs | 0 | 0 | 0 | 0 | 0 |
| New Full Degree Programs | 1 | 0 | 0 | 0 | 1 |
| New Certificate | 0 | 0 | 2 | 1 | 3 |

| Information Dissemination/Educational Outreach | | | |
| Workshops, Short Courses to Industry | 0 | 3 | 8 | 0 | 11 |
| Workshops, Short Courses to Others | 5 | 9 | 3 | 5 | 22 |
| Seminars, Colloquia, etc. | 112 | 141 | 121 | 96 | 470 |
| World Wide Web courses | 1 | 0 | 0 | 1 | 2 |

| Academic Presentations | | | | |
| Industry Presentations | 18 | 27 | 12 | 15 | 72 |
| Science Cafes | 7 | 8 | 6 | 6 | 27 |
| Visiting Speakers | 17 | 5 | 6 | 2 | 30 |
| Community Speaking Engagements | 4 | 3 | 12 | 6 | 25 |
| Newsletters | 0 | 0 | 0 | 0 | 0 |
6. Mission, Significant Advances, and Broader Impacts

The Center’s mission is to: 1) research the societal dimensions of nanoscale science and engineering (NSE); 2) train a community of scholars with new insight into these dimensions; 3) engage various publics and NSE researchers in dialogues about the goals and implications of NSE; and 4) partner with the NSE enterprise to generate greater reflexiveness in research, development, education and policy. Using the methods of real-time technology assessment (RTTA; Guston and Sarewitz 2002), CNS-ASU weaves together these activities to support a broad-based societal capacity for the anticipatory governance of emerging technologies.

The Center has made significant strides in accomplishing this mission. In particular, the Center’s RTTA methods and its anticipatory governance vision have been recognized in important scholarly venues, e.g., the field-defining Handbook of Science and Technology Studies, which includes Barben et al.’s (2008) chapter, and the series on innovation policy in Nature, which published Guston’s (2008) commentary. The Center’s work also includes a more detailed genealogy of anticipatory governance (Karinen and Guston 2010), a synoptic piece placing anticipatory governance in the NNI’s approach to responsible development and in the context of some recent scholarly debate (Guston 2014), and a historical exploration of a critical case in anticipation of the atomic bomb (Guston 2012). A forthcoming submission of a special issue (edited by Barben and Guston) on reflexive and anticipatory governance to Social Studies of Science delves deeper into the constituent capacities anticipatory governance. Beyond such publications, a number of programs and scholars have begun to adopt anticipatory governance and scrutinize it for their own purposes, from the incorporation of anticipatory governance into the programmatic agenda of the Nano-scale Informal Science Education Network’s (NISE Net) public forums (see Section 12 Outreach and Knowledge Transfer), to the work of a cadre of international scholars and practitioners who have visited CNS-ASU to imbibe its perspective (see Section 13 Shared and Other Experimental Facilities [International Collaborations]), to sessions at the annual meetings of the AAAS Science and Technology Policy Forum (May 09), the Society for the Study of Nanoscience and Emerging Technologies (annually since 09) and the Society for Social Studies of Science (F 09; F 10) dedicated to anticipatory governance, and elsewhere. Emerging dialogue and policy around responsible innovation (RI) also owes much to the emphasis on RI and anticipatory governance as well, as RI frameworks adopted, for example, by the UK Engineering and Physical Sciences Research Council show significant intellectual inheritances from anticipatory governance.

Moreover, anticipatory governance and its component capacities are represented in NNI and other official planning documents, including: endorsement of scenario development as a route to understanding nanotechnological futures, in the NNI 2007 strategic plan; highlighting of integration research as an important element in future NSE collaborations with social science, in the FY 2012 NNI budget summary from NSF; focusing importantly on anticipatory governance in the 2010 NSF/WTEC report on the future of nanotechnology; etc. Guston (2014) has begun to collect many of these responses in the community and respond to some critics that have emerged, and the funded supplement to CNS-ASU has begun to research the Center’s various impacts and outcomes, including the uptake of anticipatory governance.

CNS-ASU research is having a substantial influence on the scholarly literature. The Yearbook of Nanotechnology in Society series (Springer; Guston, series editor) has published three volumes (Fisher, Selin and Wetmore 2008; Cozzens and Wetmore 2011; and Hays, Robert, Miller and Bennett 2013). A fourth is well underway, with draft chapters from most authors in various stages of peer review (de Ridder Vignone, Miller and Barben in preparation 2014). The two-volume Encyclopedia of Nanoscience and Society (Sage; Guston, editor) was published in 2010. Both the
Yearbooks and the Encyclopedia serve community-forging purposes. The Yearbook helps create a community of scholars around a narrow topic and then provides them with relatively high visibility. The Encyclopedia has brought together a larger community of scholars in its production – roughly 220 authors – and will help introduce a younger scholarly audience – high school and undergraduate students – to nearly 500 topics in nanotechnology in society. In total, Center researchers have 11 books published, under review or under contract around Center-related material, five of which are primary CNS publications.

The Center’s researchers have published, had accepted or submitted for review 222 peer-reviewed journal articles (175 of which are primary CNS-supported publications), covering a range of outlets including:

- broad-based audiences in science and technology studies (e.g., Science, Technology & Human Values; Science as Culture; Minerva; Social Studies of Science),
- policy and innovation studies (e.g., Science and Public Policy; Research Policy; Journal of Technology Transfer, Technological Forecasting & Social Change, Review of Policy Research, Research Evaluation; Scientometrics),
- law and ethics (Science and Engineering Ethics; Journal of Law, Medicine, and Ethics, Jurimetrics),
- communication (Science Communication; Journal of Mass Communication Quarterly; Public Understanding of Science; New Media and Society, International Journal of Public Opinion Research),
- urban sustainability issues (Cities; Journal of Urban Technology, Sustainability Science),
- other interdisciplinary specialty journals (Leonardo; Appetite; Long-range Planning; China Intellectual Property), and
- specific, NSE-related audiences for
  - scientists (Journal of Nanoparticle Research; Nature Nanotechnology; Journal of NanoScience and Nanotechnology),
  - policy makers and business leaders (Nanotechnology Law and Business),
  - social scientists and humanists (NanoEthics) and
  - educators (Journal of Nanotechnology Education).

In the recent year, we have also added Proceedings of the National Academy of Sciences to the journals in which CNS-ASU researchers have published.

The Center's researchers have produced six special issues of peer-reviewed journals:

- Fisher, Science and Engineering Ethics 17(4), “Public Science and Technology Scholars”
- Bozeman and Sarewitz, Minerva 49(1) “Public Value Mapping”
- Shapira and Youtie, Journal of Technology Transfer 36(6) “Nanotechnology and Innovation Policy
- Invernizzi and Davies, Journal of Nanotechnology Law and Business 9(3) “Studying Nanotechnology in the Private Sector” and

They are at work on two additional special issues:

- Barben and Guston, Social Studies of Science and
- Selin, Futures.
Perhaps more importantly, Center faculty have assumed major leadership roles in the creation of the new *Journal of Responsible Innovation*. Launched by Taylor & Francis in early 2014, *Guston* is the founding editor-in-chief and *Fisher* is one of the associate editors.


Center researchers have further published or have forthcoming 87 book chapters (71 of which are primary CNS-supported publications), including three contributions to the field-defining *Handbook of Science and Technology Studies*, many contributions to the *Yearbooks* and other new nano-society anthologies, and major international works on interdisciplinarity, governance, risk, and innovation policy and assessment. The *Encyclopedia of Nanoscience and Society* also drew on the expertise of Center-affiliated researchers for 59 entries, or about 12% of the total number, which are listed under “Other.”

Although they are a somewhat crude measure of scholarly impact, citations to this body of published work are accumulating – more than 4900 citations as documented in Google Scholar (as of Apr 14), up from roughly 3300 citations in Apr 13, just over 1500 citations in Mar 12, 983 citations in Mar 11, roughly 500 citations in Apr 10, and 188 citations in Apr 09. The Center’s H-index has risen to 38 from 28 last year, 21 in 2012 and 19 in 2011 (indicating precisely 38 publications with 38 or more citations each). (This total does not include the roughly 85% of the 380 Google Scholar citations to the original RTTA article by *Guston* and *Sarewitz* [2002] that have occurred since CNS-ASU was founded and which represent the visibility of the Center and its core intellectual ideas as well. It also excludes some publications that do not appear accessible on Google Scholar, as well as citations to *Yearbook* chapters not written by CNS researchers or individual *Encyclopedia* entries whether or not written by CNS researchers.) Particularly pleasing about the H-index publications is their inclusion of work from almost all of the research thrusts and intellectual perspectives of the Center. H-indexed papers account for about 3000, or 61%, of the Center’s citations.¹

CNS-ASU has also attempted to make its research and other products available in other formats, including 35 reports of various types available on the Internet and numerous video and audio clips available through the CNS website, YouTube, and other organized blogs.

As evidence of its impact on education, the Center has primarily contributed to the completion of 42 student theses, including 17 doctoral theses, 3 master’s theses, and 22 undergraduate honors theses, across a variety of disciplines. CNS has contributed to the completion of an additional 25 student theses, including undergraduate honors students, STIR collaborators, CNS-Biodesign fellows and others completing the PhD+. These numbers include only a handful of roughly one dozen doctoral students whose research is formally being guided by the STIR project, as well as

¹ RTTA 1 colleagues have performed a bibliometric analysis of CNS-ASU publications using combined Web of Science and Scopus data and returned similar results, finding 4038 citations in early 2014 compared to 2917 the previous year, and an H-index of 36, accounting for 54% of CNS citations. They also found that citations to CNS-ASU publications accounted for ~40% of all citations to nano social science papers through early 2014. They have further found that mean citation rate for CNS-ASU papers is higher than for non-CNS-ASU papers, and that this difference increased between 2013 (9.86 > 6.10) and 2014 (13.09 > 7.43).
additional students who have become affiliated with that project but are not formally part of it and other students advised by Center faculty outside CNS-ASU on related topics.

Data and instruments produced by CNS-ASU are sought by and shared with an increasing number of researchers across the globe. For example, the searchable definition of nanotechnology produced by RTTA 1 has been adopted by the European Nano Observatory. The public opinion survey instrument developed by RTTA 2 was not only developed in coordination with EuroBarometer but also has been shared with researchers in Singapore, Ireland, France, and Poland. Survey data has also been provided to policy officials, including the National Nanotechnology Communication Office. NCTF data have been used not only by the distributed groups of scholars who hosted local citizens’ technology forums, but have also been provided at the request of researchers at NYU and in France. In Feb 12, CNS-ASU collaborated with librarians at UMass Amherst in submitting a $48K proposal to Institute for Museum and Library Services for a planning activity, “Nanoscience and Emerging Technologies in Society: Sharing Research and Learning Tools,” which occurred in June 13.

Center activities have also helped generate additional research projects, including approximately $5.5M of associated and spin-off awards at ASU and roughly $3.4M at the collaborating universities. At ASU, these awards include:

- Boradkar, et al., National Collegiate Inventors and Innovators Alliance, $30K, Sep 07 – May 08 (this award supported one year of InnovationSpace on CNS agenda);
- Sarewitz and Bozeman, NSF SciSIP, $203K, Oct 07 – Sep 10, Public Value Mapping: Developing a Non-Economic Model of the Social Value of Science and Innovation Policy (this award included collaborations with TRC 1 and RTTA 4);
- Sarewitz and Fisher, NSF SciSIP, $35K, Aug 10-Sep 10, How to STIR Public Values for Policy Making: A Supplemental Proposal for Web-based Dissemination of Two SciSIP Projects (a supplement to the PVM award above, this award extended outreach and dissemination via video for both PVM and STIR projects across RTTA 1 and RTTA 4);
- Herkert, Wetmore, et al., NSF Ethics Education in Science and Engineering, $300K, Jan 08 – Dec 10 (this award tested a number of macro-ethics education interventions, several initially piloted by CNS-ASU);
- Guston, NSF Conference Award for the Gordon Research Conference, $60K, Aug 08 (this award supported the GRC on “Governing Emerging Technologies”);
- Guston, Greenwall Foundation Conference Award for the Gordon Research Conference, $10K, Aug 08 (this award supported the GRC on “Governing Emerging Technologies”);
- Fisher and Guston, NSF Socio-Technical Integration and Research, $540K, Apr 09-Mar 12 (this award extends the RTTA 4 agenda to create an international team of doctoral students doing interventionist-oriented comparative laboratory ethnographies);
- Fisher, National Nanotechnology Infrastructure Network, 09-10, $5,300 (this award documents the integration of social and ethical considerations into a number of NSEC and NNIN sites);
- Corley, Marchant and Sylvester, DOE, $245K, Sep 10-Aug 12, Governing Nanotechnology Risks and Benefits in the Transition to Regulation: Innovative Public and Private Approaches (this award draws on and extends Corley’s RTTA 2 work);
- Corley, Lincoln Center for Applied Ethics, ASU, $20K, May 10 – Dec 11, An Exploration of the Ethical Implications of Human Exposure to Nano-Materials in University Research Laboratories (this award draws on and extends Corley’s RTTA 2 work);
- Selin, Science Museum Minnesota, $9K, Sep 11-Dec 11, Civic Scenarios on Climate Change Adaptation (this award extends Selin’s RTTA 3 research and outreach);
- Wiek, Housing and Urban Development, $2.9M, Reinvent Phoenix: Cultivating Equity,
Engagement, Economic Development and Design Excellence with Transit-Oriented Development (continues TRC 2 work to address socio-technical change as a key aspect of sustainability transition research);

- **Guston**, NSF, Workshop on Anticipatory Governance of Complex, Engineered Nanomaterials, $34K (to apply anticipatory governance framework to advanced generation nanomaterials);
- Graduate students Foley and Kalinowski, $2K, ASU Graduates in Integrative Society and Environment Research on “Future Visions at M52: Investigating Social, Ethical, and Legal Constraints;”
- **Lobo** et al. DOE, $98K, Sunshot Seed grant for “Forecasting and Influencing Technological Progress in Solar Energy;”
- Wender et al., $2K, ASU Graduates in Integrative Society and Environment Research on “Burdens and Barriers to Terrawatt-scale Photovoltaic Energy;”
- Seager, **Selin** et al., NSF NUE, $200K, Cross-disciplinary Education in the Social and Ethical Aspects of Nanotechnology, Nov 13 – Oct 15;
- Wetmore et al., NSF, $248K, Capacity Building in Computer Science as a Driver of Innovation, Oct 13 – Sept 15;
- **Guston** and **Fisher**, NSF, $500K, NSF SAVI: Virtual Institute for Responsible Innovation, Oct 13 – Sept 16; and

At GA Tech, these awards include:

- **Porter**, NSF National Partnership for Managing Upstream Innovation, $45K, Nov 04 – present;
- **Shapira, Youtie, Rogers**, NSF Measurement and Analysis of Highly Creative Research, $340K, Jan 08 – Dec 10;
- **Porter** et al., NSF Measuring and Tracking Research Knowledge Integration $393K, Sep 08 – Aug 11;
- **Porter** et al., NSF NER: Representations of Active Nanostructures Across Scientific, Popular, and Policy Realms of Discourse, $85K, Jan 07 – Aug 09;
- **Porter** et al., UK Royal Commission, $20K, Jan 08 – Apr 08;
- **Porter, Youtie** and Meyers, Euronano, $21K, Jul 07 – Jan 08;
- **Porter** et al., NSF SciSIP, TLS: Revealing Innovation Pathways, April 2011- Jan 2014, $419k;
- **Shapira**, et al., UK Economic and Social Research Council, Emerging Technologies, Trajectories and Implications of Next Generation Innovation Systems Development in China and Russia $350K, Sep 2012-Sep 2014;
- Arora, Georgia Tech Research and Innovation Conference, $1.5K, Feb 12;
• Shapira (with Gok, PI), Novel data analysis, synthetic biology. $12K, 2014; and

At Wisconsin, these awards include:
• Scheufele, University of Wisconsin—Madison Graduate School, Science and Social Responsibility: Tapping Values and Perceptions among Researchers in Nanotechnology, $9,029, Sp 07;
• Scheufele, NSF, Media, Talk, and Trust: The Social Amplification of Risk during Site Selection for a Bio-research Facility, $400K, Sep 08- Oct 10;
• Scheufele (co-PI with PI Berube at NCSU), NIRT: Intuitive Toxicology and Public Engagement, $1.4M ($150K at UW), Sep 08- Oct 10;
• Scheufele (consultant with PI Hallman at Rutgers), USDA CSREES National Research Initiative (NRI) Food Nanotechnology: Understanding the Parameters of Consumer Acceptance, $200K, Sep 08- Oct 10;
• Scheufele (with PI Wilson), DOE, Developing a User Experience for the Next Generation Nuclear Fuel Cycle Simulator, $1.2M, Sep 11-Oct 14;
• Scheufele (sub-PI with PI’s Larry Bell, Paul Martin & Robert J. Semper), NSF, Nanoscale Informal Science Education Network Award # DRL-0940143 $160K (total center grant: $4.2 million) 2011-2015; and

CNS-ASU has been a force for institutional change at ASU and its collaborating universities. Programs have adopted CNS-ASU tools and approaches as well as the broader theme of anticipatory governance, which has emerged as an important element in the conceptualization of new ASU initiatives. In addition to having created numerous undergraduate and graduate courses and its PhD+, CNS-ASU has:
• collaborated with ASU’s Biodesign Institute to require integrated societal training of the doctoral students in its Biological Design PhD program;
• collaborated with ASU’s Professional Science Master’s program in Nanoscience to offer a societal training course in the new curriculum;
• collaborated with ASU’s Professional Science Master’s program in Solar Energy Engineering and Commercialization to offer integrated societal training in the new curriculum;
• collaborated with ASU’s NNIN node to develop a training program in the societal dimensions of nanotechnology and in informal science education for its users;
• helped instigate the creation of a PhD+ program at GA Tech;
• provided leverage for a proposal by Scheufele at Wisconsin for a “Science and Culture” cluster hire to add personnel to the infrastructure that CNS has supported there;
• collaborated with ASU’s university-wide energy initiative, LightWorks, to integrate research on the social and governance challenges of energy systems transitions; and
• collaborated with a number of proposals to NSF (STC, ERC, IGERT and NUE), DOE (ARPA-E and Hub) and NIH emerging from ASU containing programs that CNS pioneered. Funded NSE and emerging technology awards at ASU with CNS-ASU partnerships and activities include over $33M in awards:
  • Lindsay, NSF NIRT for organic photo-voltaics, $1.1M, Sep 06 – Aug 10;
• **Posner**, NSF CBER, Interaction of Engineered Nanomaterials with Artificial Cell Membranes, $313K, Sep 09 – Aug 12;
• **Posner**, NSF CBER, Collaborative Research: Rational Design of Enhanced Catalytic Nanomotors, $600K, Mar 09 – Feb 12;
• **Honsberg**, NSF ERC, Quantum Energy and Sustainable Solar Technologies, $20M, Aug 11 – Jul 16;
• **Vermass**, NSF IGERT, Solar Utilization Network, $3M, Jun 12 – May 17; and

Additionally, CNS-ASU researchers have the following associated or collaborative proposals that incorporate CNS ideas under review or in preparation:
• DuBois et al. (with **Guston** and **Bennett**), NIH, Broadening Experiences in Scientific Training (BEST): Cross-training in Biomedical Research: Business, Policy, Law, and Communications, $5M;
• Raupp (with **Bennett** and **Wetmore**), NSF ERC, Sensing and Processing via Autonomous Conformal Electronics Systems;
• Kavazanjian (with **Bennett**), NSF ERC Bio-mediated and Bio-Inspired Geotechnics;
• **Guston**, Murray and Brian, NSF, Workshop: Societal Aspects of Synthetic Biology, $150K; and

While **Section 13 Shared and other Experimental Facilities** details the visits and other contributions by more than international scholars and practitioners to the Center from roughly two dozen countries, CNS-ASU scholars have also engaged in substantial international collaborations based on their Center-related work. For example:
• **Selin** is a senior researcher on a EU 7th Framework funded project led by Strand (Bergen) on “Integrated Assessment of Societal Impacts of Emerging Science and Technology from within Epistemic Networks,” to investigate how different methods of analyzing and assessing new and emerging fields of technology can be better integrated, $2.1M, Apr 12-Mar 15.
• **Guston** is a named international associate on a five-year project funded by the Leverhulme Trust led by Nerlich (Nottingham) on “Making Science Public,” to investigate how changes in public engagement with science affect the theory and practice of democracy, $2.84M, May 12-Apr 17.
• **Shapira** and **Youite** are principals with the Innovation Co-Lab – a collaboration of researchers at Georgia Institute of Technology, the University of Manchester (UK), and the Beijing Institute of Technology (China) to advance methodologies and analyses to anticipate the trajectories of emerging technologies. The Co-Lab’s focal technologies include graphene, other nanotechnologies and advanced green goods. Co-Lab projects are sponsored by the British Council, the UK Economic and Social Science Research Council, and Chinese Ministry of Science and Technology. Georgia Tech CNS-ASU researchers **Porter** and **Rogers** and students **Arora**, **Carley**, and **Li** are among those also engaged in the Innovation Co-Lab.
• **Shapira** was appointed in 2011 to the advisory board of the Foresight Centre, National Research University - Higher School of Economics (HSE), Moscow, Russia, which focuses on the analysis of emerging technologies including nanotechnology. The Georgia Tech RTTA1 group is a partner with HSE and the Beijing Institute of Technology in a successful University of Manchester proposal to examine nanotechnology emergence in the rising powers of China and Russia.

• **Scheufele** is member of the External Advisory Committee for the **Wellcome Trust Monitor**, a national tracking survey conducted by the Wellcome Trust in London, UK. He advises on questionnaire construction, data analysis etc.

• **Wetmore** was a “Bright Ideas” Visiting Research Fellow in Summer 2011 at the ESRC Genomics Policy & Research Forum, University of Edinburgh, Scotland to continue his collaborations on developing new ways to help scientists and engineers better understand the social implications of their work.

• **Fisher** serves on the Scientific Advisory Boards for the “Applied Metagenomics of the Watershed Microbiome” project (Tang, PI), funded by Genome Canada, and for the “Exploring Possibilities for Patient Involvement in Translational Medicine” project (Boenink, PI), funded by the Netherlands Genomics Institute and Centre for Translational Molecular Medicine.

The following section briefly summarizes the most significant advances of the Center over the last year in terms of fundamental knowledge and technology (here conceived as applied and/or reflexive knowledge, processes, and capacities, often but not exclusively for internal use).

**Fundamental knowledge.** Each research program, and most individual research projects, contributed significant advances in fundamental knowledge of the societal aspects of nanotechnology in the last year. This section provides some highlights.

• **RTTA 1 Research Program Analysis:** Analyzing extensive global databases of Science Citation Index records, other publication databases, and patent databases (MicroPatents, PatStat), CNS-ASU researchers have found:
  
  o **RTTA 1/1:** Nanotechnology articles have increasingly used more differentiated and application oriented terms based on a social network analysis of nano-prefixed terminology (Arora et al. 2014);
  
  o **RTTA 1/1:** The US leads all other countries in numbers of nanotechnology publications appearing in 2011-2013 in three top science journals and in total citations to all nanotechnology journal articles over the same period. However, China leads all other countries in total number of nanotechnology articles and in number of citations to articles published in 2013 (Li, et al. 2014).
  
  o **RTTA 1/2:** Acquired firms in the nanotechnology domain provide complementary capabilities to their acquirers (Youtie and Kay 2014).

• **RTTA 2 Public Opinion and Values:** From large scale public opinion surveys and surveys of high-ranking nano-scientists and engineers, CNS-ASU researchers have found:
  
  o **RTTA 2/1:** Knowledge gaps about nanotechnology since 2004 between the least educated and most educated members of the US public have widened. Americans with at least a college degree have shown an increase in understanding of the technology, while knowledge about nanotechnology has declined over time for those with education levels of less than a high school diploma. The Internet is one of the most effective methods in closing gaps and informing the less educated about nanotechnology (Cacciatore, Scheufele & Corley, forthcoming).
- RTTA 2/2: Nano-scientists and engineers use different heuristics when thinking about regulating commercial nanotechnology than when thinking about regulating academic nanotechnology.
- RTTA 2/3: Collecting and mining data from traditional and new media in collaboration with the University of Wisconsin Nanoscale Science and Engineering Center show a more pessimistic than optimistic outlook toward nano in social media.

- RTTA 3/1 Scenario Development: From investigating alternative futuring methods, RTTA 3 researches have found:
  o There is an appropriate role for plausibility, as opposed to probability or risk, in scenario development work (Ramirez and Selin 2014).
- RTTA 4/4: Reflexivity and Integration: Through a set of integrative research and educational activities with NSE researchers, CNS-ASU researchers have:
  o developed the following a general and succinct definition of socio-technical integration that applies not only to the laboratory but to all levels and forms of reflexive expertise: “any process by which technical experts account for the societal dimensions of their work as an integral part of this work.”
- TRC 1: Through field work in South Africa, combined with bibliometric and patent analysis and other documentary research, research on Equity, Equality and Responsibility has found:
  o The pro-poor promise of a number of nanotechnologies is not playing out well in actual nanotechnology research agendas (various publications).
- TRC 2: Through work with stakeholders in the Phoenix innovation system, TRC 2 researchers have found:
  o Research on current and alternative future governance arrangements will help determine the extent to which nanotechnology development, as presently overseen, ameliorates or perpetuates societal challenges.

Technology (in this case, mostly applied and/or reflexive knowledge, processes, methods and capacities; often these are developed in one part of CNS-ASU and used in another, thus forming the intellectual core of “ensemble-ization”).

- RTTA 1 Research and Innovation System Analysis:
  o A new patent mapping system that considers how patents cite one another was developed as a base map tool for distribution to researchers, companies and policymakers to enable them to understand the relationships between technologies and view particular portfolios of patents to see how they may come together to spur disruptive new areas of innovation (Kay et al, in press).
  o Several targeted bibliometric studies supported ongoing CNS-ASU work.

- RTTA 2 Public Opinion and Values:
  o The RTTA 2/1 researchers are coordinating data collections with related efforts at Wisconsin, Singapore, Rutgers, Universität Hamburg, and elsewhere to build comparable data sets that will inform policy making and outreach efforts. Because RTTA 2/1 has played a prominent role in sharing these innovations with other scholars, the leaders of the POVs team serve as consultants or co-PIs on other related NSF and USDA grants. This methodological outreach is being formalized by RTTA 2/1 researchers through the formal archiving and sharing of data collection instruments.

- RTTA 3 Anticipation and Deliberation:
  o InnovationSpace discloses three inventions per year to Arizona Technology Enterprise (AZTE) under CNS-ASU sponsorship.
The development of the Futurescape City Tours marks an innovation in public engagement methods that give priority to enabling citizen-set agendas, use multi-media tools to support 'material deliberation' (Davies et al 2013), and propose capacity-building as a worthwhile outcome.

- RTTA 4 Reflexivity and Integration:
  - RTTA 4/1: A large part of the Center’s activity relates to concept work that circulates broadly among the various communities, and “anticipatory governance” is the concept with the highest influence rating.
  - RTTA 4/2: Laboratory engagement studies that made frequent collaborative use of the STIR decision protocol (N=12) were found to be more likely to enhance the value deliberations and material adjustments of participating scientists and engineers than those that make infrequent (N=10) or no (N=7) collaborative use of the protocol.

- TRC 1 Equity, Equality and Responsibility
  - To help engineers and scientists begin to recognize the need to listen and develop the skills necessary to engage in community development, TRC 1 has developed several interactive modules (including "contextual listening," "socio-technical system mapping," and "the Ghanaian Village Case study") that can be plugged into other programs or used as stand alone exercises.

- TRC 2 Urban Design, Materials and the Built Environment
  - Continued work to develop the Nanotechnology in City Environments (NICE) database has drawn 10,000 unique visitors in the past year alone (representing a 10-fold increase). Visits track from 1,000 different cities globally, helping to diffuse information on nanotechnology applications in urban environments.

Education and Training:

- At the post-doctoral and junior researcher level, CNS-ASU continues to train high-quality junior researchers and place them into important positions. Most recently, de Ridder-Vignone, a post-doc with RTTA 3, will begin a tenure track position at James Madison University. Reinsborough will begin a second post-doc at King’s College, London.

- At the graduate level, CNS-ASU has involved roughly two dozen graduate students (funded, unfunded, and visiting) in its YR 9 research activities, not including another approximately 20 STIR students. The Center held its second Winter School and completed its design studio. We are collaborating to teach students at ASU’s Professional Science Master’s Program in Nanoscience, Professional Science Master’s Program in Solar Energy, and in the Biological Design PhD program, and we continued other courses at the graduate level. The Center continues to play an integral role in the Human and Social Dimensions of Science and Technology doctoral program and the Professional Science Master's degree program in Science and Technology Policy, both coordinated by Center senior personnel Miller at ASU. CNS-ASU graduate students completing their doctoral dissertations have been placed at University of Georgia (Cacciatore, Wisconsin), University of Utah (Yeo, Wisconsin), and James Madison University (Conley, ASU). The first graduate student to complete the Certificate in Responsible Research and Innovation has been accepted to Harvard Law School.

- At the undergraduate level, CNS-ASU continues to teach classes influenced by the Center, including “Introduction to Science and Technology Policy” for 125 undergraduates at ASU. InnovationSpace continued to make contributions in the cross-training of business, design, and engineering students and the production of provocative and concrete ideas of future nanotechnology products.
In informal science education, CNS-ASU deepened its strategic and highly generative partnership with NISE Net, not only participating in NanoDays in Mar 14 but more importantly publishing with NISE Net a training guide for museum personnel to help them manage discussions about societal issues.

In training for scientists and engineers, CNS-ASU continues its improved relationship with NNN through the local node at ASU, providing both required social and ethical implications training and an informal science communication program to NNN users and extending the model of training included in the NG-NNIN proposal to other partnerships.

**Industrial collaborations.** The most significant private-sector collaborations that CNS-ASU participated in over the past year are:

- Collaborations between researchers in RTTA 1/1 and an Atlanta-based producer of data-mining software tools have resulted in improved ways to work with unstructured text new approaches to development of patent mapping tools (Kay et al., in press);
- Based on industrial engagement and personal interviews with actors in the building construction industry, Arora et al. (2014) in RTTA 1 and TRC 2 find that although actors in the building construction domain have awareness of manufactured nanotechnology products, adoption of these products is limited along multiple dimensions; intermediaries could help to reduce risks involved in adoption of these products;
- In RTTA 4/2, the use of the STIR protocol with five project leaders to integrate social and ethical aspects measurably improved industrial R&D project performance, in contrast to five ‘controls’ who did not use the protocol (Flipse et al., 2013);
- the disclosure of InnovationSpace inventions to AZTE and other private sector contact through ISpace;
- Involvement of numerous private sector organizations in the implementation of the Futurescape City Tours, including from the energy sector (e.g. NRG, Western Massachusetts Electric Company), transportation sector (Pioneer Valley Transit Authority), business development (South of Market EcoDistrict), architecture (Shannon and Wilson, Inc., Mayor-Reed architects), nanotechnology (The Alberta Centre for Advanced Micro Nano Technology Products, Quantum and Technologies Inc.), and water (The E.L. Smith Water Treatment Plant);
- TRC 1 at Georgia Tech partnered with the Sickle Cell Foundation of Georgia to give engineering students real world experience of how to develop community collaborations. The Sickle Cell Foundation gave us an inside look at the problems faced by those who suffer from Sickle Cell Anemia and Sickle Cell Trait, and we in turn developed potential solutions and strategies for tackling these difficult issues;
- Previous collaborators from the Arizona Technology Council, Arizona Biotechnology Council, Arizona Nanotechnology Cluster, Greater Phoenix Economic Council, Arizona Technology Investors Forum, Phoenix Union School District, and Arizona Science Museum contributed to the scenario study through participatory workshops, interviews, and feedback; and
- Publication of a special issue of the *Journal of Nanotechnology Law and Business*.

The following section briefly describes the current and potential impacts of CNS-ASU on teaching, training, and learning; outreach to pre-college institutions; broadening the participation of underrepresented groups; enhancement of infrastructure of research and education; dissemination to scientific and technological communities; and benefits to society.
Teaching, training and learning. At any given time, CNS-ASU, across its three constituent universities, is training in various capacities approximately one-half dozen junior research faculty and post-doctoral fellows, two dozen graduate students, and one dozen undergraduate students in the societal aspects of nanotechnology. At the constituent universities, most of this training consists of working on CNS-related research projects under the subcontracts to those universities. In each location, but at Wisconsin in particular, the community of trainees is larger than that of funded student researchers because the data developed by the Center are too extensive to be analyzed entirely within the budget. At Wisconsin and ASU, CNS-related research is being incorporated into numerous classroom modules and activities. At ASU, CNS has engaged in extensive training and curriculum development and innovation. In this reporting year, CNS-ASU has continued to influence undergraduate courses in disciplinary areas, expanded its graduate training with new coursework and research opportunities for both social scientists and NSE students, and collaborated with NISE Net to expand the inclusion nano-in-society ideas in informal science education. The graduate studio co-led by Wiek and Petrucci created a video depicting the future urban form of Phoenix enabled by nanotechnology. The videos were shared with diverse audiences: science-policy experts in Washington, DC, academic scholars in Boston, MA, high school students in Phoenix, AZ, and members of the United States Green Building Council-Arizona Chapter in Tempe, AZ.

Outreach to pre-college institutions. CNS-ASU has arranged for continuing education credit for in-service teachers for attending its Science Cafes. In previous years we have reported on the development and teaching of what we believe to be the nation’s only graduate-level course for in-service high school teachers in nanotechnology and society, and on our inability to find an appropriate financial model for attracting enrollment to the course. We previously modified the course for inclusion in the PSM in Nanoscience degree program, and we have taught it again the current year. The Encyclopedia of Nanoscience and Society, published in YR 6, has high school and college libraries as its target market. We are also orienting our interactions with NISE Net to help develop materials for the in-service teachers with whom science museums work. In conjunction with ECAST, CNS-ASU has developed a model for deliberative engagement with high school students over issues in science and emerging technologies. Three (on geengineering, synthetic biology, and biodiversity) were conducted in prior years. At ASU, we continue our deepening relationship with Phoenix Bioscience High School. In the reporting year, we involved the school in the Futurescape City Tours and screened and discussed the video developed by the design studio about a nano-enabled Phoenix in 2050.

Broadening participation of under-represented groups. CNS-ASU, including its constituent universities, has developed a strong record of including women in key research and leadership positions and recruiting members of under-represented groups into graduate and undergraduate research positions. In most measurement categories, CNS-ASU equals or exceeds national averages. In previous years, we have focused attention on disability communities as an under-represented population through the activities of TRC 1 Equity, Equality, an Responsibility, (former) TRC 2 Human Identity, Enhancement, and Biology, and Miller’s interactions with the IGERT on Person-Centered Technologies. In a previous year, we replaced the symposium for under-represented students with a training activity more akin to the DC Summer Session and other training activities that CNS-ASU has made successful, but targeted for under-represented students in partnership with the Hispanic Research Center (HRC). Held for the first time in Sp 09 for two dozen graduate students from under-represented communities, the seven-week course was quite successful. We repeated it in Fall 11 but did not do so as planned in Fall 13 because of lack of funding at HRC.
Enhancement of infrastructure for research and education. CNS-ASU maintains a web site (http://cns.asu.edu) that provides information about its research, education and outreach programs to a general audience. It was redesigned last year and we continue to tweak it. CNS-ASU has most of its monthly seminars and occasional speakers’ presentations available on the web site in audio, video, and PPT versions – including new video formats on YouTube, and the re-designed site will emphasize access to video and other resources. The website connections to several associated projects in-depth, including:

- The Plausibility Project site (http://www.cspo.org/projects/plausibility/), which has detailed information, references, and papers about the project;
- The STIR project website (http://cns.asu.edu/stir/) and Facebook site, which provides general information about the project and a password protected site for collaborative work among the far-flung international STIR network; and
- The Virtual Institute for Responsible Innovation (http://cns.asu.edu/viri), which has a temporary rudimentary site publishing news and linking to a listserv established to link scholars and others with an interest in responsible innovation.

CNS-ASU has been crucial in the creation and maintenance of the Society for the Study of Nanoscience and Emerging Technologies (S.NET; Guston is a founding member of the board, a member of the first and second program committees, and a co-chair of its third program committee). It co-hosted, with CNS-UCSB, the third annual meeting of S.NET in Nov 11, with more than 200 attendees from more than 20 countries. CNS-ASU co-sponsored, with NNIN, NISE Net and other ASU projects, the first Congress on Teaching the Social and Ethical Implications of Research, with more than 100 participants. CNS-ASU has also created a number of research tools and instruments, e.g., the searchable definition of nanotechnology and the databases derived with it, survey protocols and opinion data, and the NCTF reports, internet transcripts and video data that have been sought by and provided to other scholars. CNS-ASU has also received more than 100 international visiting students, scholars and practitioners seeking a vibrant intellectual community and training in the Center’s methods.

Dissemination to scientific and technological communities. CNS-ASU has engaged in extensive dissemination activities, both to its social science and humanities colleagues, but also to the community of NSE researchers with whom it interacts. Roughly 20% of its published, forthcoming or under review journal articles appear in journals like Nature Nanotechnology, Journal of NanoParticle Research, Journal of Nanoscience and Nanotechnology, EMBO Reports, and others that are oriented toward science and engineering researchers. We have also published in trade and professional journals that target scientists, e.g., Materials Today and Nano Today, and have published one commentary in Science and two in Nature, as well as letters in both journals. CNS-ASU researchers have given nearly 800 presentations, roughly 60% of which were delivered to their social science colleagues and roughly one-third of the remainder to targeted audiences of scientists and engineers. Our dissemination activities have also included supported and unsupported invitations to our All Hands meeting, extended to roughly 10 individuals, including students, each year, and the workshops we conducted in YR 9. Dissemination to colleagues also includes the Winter School.

Benefits to society. In its Jul 07 memorandum, NSF describes a set of questions (sub-criteria) related to its broader impacts criterion. Here we articulate the contributions of CNS-ASU for each of these sub-criteria:

- “How well does the activity advance discovery and understanding while promoting teaching, training, and learning?” The integration of research, education, and outreach is a particular
focus and strength of CNS-ASU, and many of its programs are designed toward this goal from the outset.

- CNS-ASU has teaching, training, and learning projects at all levels from the pre-college education to post-doctoral training, as well as informal science education projects and training for scientists and engineers.
- Most of these teaching, training, and learning projects integrate research, education, and outreach, e.g.:
  - Students and trainees participate in the NISE Net-sponsored NanoDays by staffing a booth of nano-demonstrations at a local arts festival;
  - Undergraduate research, e.g., as represented in the third Yearbook, is well-integrated with research programs;
  - Graduate course development, e.g., the design studio conducted in Sp 13 is driven by research interests and outreach opportunities;
  - Research frames are brought to bear on high school engagement programs in geengineering, synthetic biology, and biodiversity;
  - CNS-ASU research activities become case studies for concurrent educational activities, e.g., integrating nanotechnology cases into the units of “Introduction to Science and Technology Policy;” and
  - CNS perspectives are incorporated into interdisciplinary graduate training through the participation of Miller and Guston in IGERT programs.
- CNS-ASU partnerships with NSE researchers have enriched its Science Cafes, which local teachers may use for credit;
- CNS-ASU trains a small number of CNS-BiodeSign Fellows, CNS-FSE Fellows, and other PhD+ students to conduct societal implications research or perform outreach projects around their NSE research, and this program is expanding to GA Tech;
- Student authors are included on a large plurality of CNS-ASU manuscripts;
- Students are first or sole-author on roughly one in six CNS-ASU presentations, and they have presented their CNS-related work in a variety of venues;
- CNS-ASU has created and will continue to develop a section of its website to serve as a clearinghouse for nano-in-society curricular activities.

- “How well does the proposed activity broaden the participation of underrepresented groups (e.g., gender, ethnicity, disability, geographic, etc.)?” CNS-ASU has established a strong record for the participation of women and underrepresented groups. For the Center, however, diversity is not just a matter of inclusion of a diverse research population but making aspects of diversity explicit parts of the research agenda.
- CNS-ASU fosters research topics that explicitly address issues of underrepresented groups, e.g.:
  - RTTA 1/1 Innovations Systems Assessment has investigated female involvement in nanotechnology patenting;
  - A dissertation across RTTA 3 and TRC 1 addresses how under-represented perspectives were or were not included among the groups participating in the National Citizens’ Technology Forum; and
  - An entire research program area on Equity, Equality and Responsibility (TRC 1), which in part addresses ethnic and geographic issues in the distribution of benefits and risks from nanotechnologies; and
- CNS-ASU collaborates with the Hispanic Research Center on science policy training for its two dozen graduate-level fellows from underrepresented groups;
- Through Miller, CNS-ASU is collaborating on an IGERT award to ASU’s Panchanathan on “Person-centered Technologies and Practices for Persons with Disabilities.”
"To what extent will it enhance the infrastructure for research and education, such as facilities, instrumentation, networks, and partnerships?" CNS-ASU envisions itself as a national and international leader in promoting research, education, and outreach in nano-in-society topics and in integrating those topics into NSE research and education settings.

- CNS-ASU exists as the largest node of the NSF-instigated nano-in-society network and has taken leadership in the generation of the following networks and collaborations (outside ASU):
  - CNS-ASU has hosted more than 100 international visitors, from 24 different countries;
  - CNS-ASU has become a "core partner" in NISE Net, recognizing the extent and depth of collaborations centered on enhancing informal science education with expertise from the societal aspects of NSE;
  - The Center conducted its second Winter School on the Anticipatory Governance of Emerging Technologies, which involved more than one dozen junior scholars;
  - The associated STIR project leads an expanding international network of graduate students and laboratories; and
  - The associated VIDI has begun to link roughly one dozen centers of excellence in responsible innovation into a productive network.

- Within ASU, CNS-ASU is a hub for transdisciplinary research and teaching, with specific activities including:
  - CNS curricular offerings currently enhance graduate education in the Biodesign Institute, the Ira A. Fulton Schools of Engineering, the Department of Physics and the Department of Chemistry and Biochemistry;
  - CNS supports InnovationSpace, which bridges the schools of design, engineering, and business;
  - CNS has helped create a new, cross-disciplinary undergraduate certificate in Science, Technology and Society;
  - CNS graduate coursework helps link the Schools of Politics and Global Studies, Human Evolution and Social Change, Life Sciences, and the Human and Social Dimensions of Science and Technology doctoral program;
  - CNS has led the creation of a new graduate certificate in responsible research and innovation; and
  - CNS collaborative research and teaching activities are included on virtually every large NSF proposal (IGERT, ERC, SRN, STC) submitted by ASU.

- CNS-ASU partners with the Arizona Science Center for the production of monthly Science Cafes during the academic year;

"Will results be disseminated broadly to enhance scientific and technological understanding?" CNS-ASU aims to reach a variety of audiences – scholarly, professional, and public – with its research, education, and outreach activities.

- CNS-ASU's e-mail distribution list reaches roughly 1400 individuals;
- CNS-ASU researchers have given nearly 800 talks across all audiences since the inception of the Center, with roughly 100 in YR 9 alone;
- CNS-ASU targets networks and user facilities for the distribution of nano-in-society training material, e.g.: NISE Net has disseminated CNS-ASU products to approximately 300 museums and other participants in NanoDays;
- CNS-ASU conducts monthly (academic year) Science Cafes – many directly involving CNS personnel – during the academic year, at the Arizona Science Center;
• CNS-ASU has a contract with Springer to produce the first five volumes of the *Yearbook of Nanotechnology in Society* (Guston, series editor), the first three of which are published, and the fourth of which is significantly in preparation;

• CNS-ASU Director Guston has published the two-volume *Encyclopedia of Nanoscience and Society* (Sage, 2010) that transmits detailed concepts in nano-in-society to high school and college students;

• “What may be the concrete and demonstrable benefits of the proposed activity to society?” The concept of anticipatory governance – comprising foresight, engagement, and integration – provides the intellectual framework for the broader benefits to society that CNS-ASU seeks to generate.

  o Foresight activities create an opportunity for diverse publics to encounter, explore, and evaluate nanotechnologies prior to their actual emergence;

  o Engagement activities, including the small-scale intensive Science Cafes as well as informal science education activities informed by CNS perspectives and the larger-scale piloted Futurescape City Tours, create more informed citizens on important topics in nano-in-society;

  o Interaction with NSE researchers, including courses, training activities, workshops, laboratory collaborations, and interventions results in identifiable changes in knowledge, identity, and practice in the laboratory;

  o CNS-ASU has had important informational and educational exchanges with decision makers, including:

    ▪ Shapira’s presentation to the OECD/NNI International Symposium on assessing the Economic Impact of Nanotechnology;

    ▪ Guston’s presentation on a panel at the Brookings Institution in Washington, DC on “Rethinking Responsibility in Innovation.”

    ▪ The Center’s collaboration with the CSPO office in Washington, DC on the “New Tools for Science Policy” series, which has hosted CNS scholars Bennett and Petrucci and Foley in conversations with 30-40 science policy makers in the reporting year.

    ▪ Scheufele co-organized, with Ralph Cicerone (NAS), Barbara Schaal (Washington University), Alan Leshner (AAAS), and Baruch Fischhoff, the Sackler Colloquium at the National Academy of Sciences on “The Science of Science Communication II.”

    ▪ Porter, Shapira and others from RTTA 1 performed an assessment of the NNI that was used and cited throughout the President’s Council of Advisors on Science and Technology (PCAST)’s congressionally mandated biennial review, *Report to the President and Congress on the Fourth Assessment of the National Nanotechnology Initiative.*
By illustrating relationships between technologies, including their degree of similarity and interdisciplinary intersections, the new patent mapping system reveals innovation hotbeds, trends of technology emergence, discipline evolution, and forces acting on innovation.

Offering unique insight for anticipatory governance, research funding, and academic program development, the mapping system has appeared in Wired-UK, the MIT Technology Review, and Futurity, among other publications. An article on the patent mapping research is forthcoming in the Journal of the American Society for Information Science and Technology (JASIST).

Together with Dr. Philip Shapira, also of Georgia Tech, and Dr. Jose Lobo of ASU, Dr. Jan Youtie co-leads the Real-Time Technology Assessment (RTTA 1) at CNS-ASU that focuses on the scope of the Nanoscale Science and Engineering (NSE) enterprise and its effects on public values and outcomes.
When it comes to emerging areas of science, including nanotechnology, public engagement, and civil disagreement help improve awareness and understanding of new technologies. The Internet, and in particular sites enabling direct and open exchange among users, held the promise of more robust public discussions. However, says Scheufele, the Internet mostly encourages users to surround themselves with likeminded information and people, and though comment sections do offer a place to disagree, anonymity fosters debate that’s anything but civil. Furthermore, Scheufele’s research showed that the tone of comments responding to a nanotechnology article not only influenced readers’ trust of the source, but also their understanding of the science. In response to these findings, Popular Science closed their comments. But Scheufele argues that rather than shut down all debate, we need to find ways to encourage heterogeneous and civil exchanges as communication technology develops.

In a TEDx Talk, Dr. Dietram A. Scheufele questions the promise of the Internet to offer a space for healthy civil disagreement. He offers 3 suggestions to begin moving toward this ideal:
1. Reduce anonymity.
2. Increase opportunities for “informational serendipity.”
3. Encourage more people to join, rather than simply observe, debate.

The talk may be viewed at http://www.youtube.com/watch?v=-2MvS4gm_mo.

Scheufele’s work focuses on the role that social media and other emerging modes of communication play in our society. In September, he co-organized a National Academy of Sciences Sackler colloquium on the “science of science communication” and spoke specifically about the politicization of science in the modern world of communication.

Along with Dr. Elizabeth Corley at ASU, Dr. Scheufele leads the Real-Time Technology Assessment (RTTA 2) research thrust at CNS-ASU that explores the understanding of nanotechnology among the general public and the role of the media in reflecting and influencing that understanding.

Dietram A. Scheufele | University of Wisconsin-Madison
John E. Ross Professor of Science Communication
Co-Principal Investigator, CNS-ASU
2013 Fellow, American Association for the Advancement of Science (AAAS)
As they visited power plants, canals, laboratories and other urban atmospheres, the citizens took photographs to capture their impressions about the past, present, and future.

Futurescape City Tour Project Expands to Five More Cities

Researchers selected tour sites based on citizens’ concerns and curiosities about their city. During the tour, citizens met with city officials, scientists, and business leaders to explore urban nanotechnologies. As they visited power plants, canals, laboratories and other urban atmospheres, the citizens took photographs to capture their impressions about the past, present, and future.

Participants later shared their photos and impressions of the city and discussed their observations, critiques, and hopes for the future of their city.

Dr. Cynthia Selin explores future-orientation from an interdisciplinary perspective, asking questions about how foresight is applied in the governance of emerging technologies.

Along with Dr. Kelly Campbell Rawlings from the Sol Price School of Public Policy at USC, Dr. Selin leads CNS-ASU’s Real-Time Technology Assessment (RTTA 3) exploring plausible futures and elucidating public preferences about the future.
The Socio-Technical Integration Research (STIR) project has shown that, under certain conditions, embedding humanists into nanotechnology and other laboratories yields concrete results. When the STIR protocol is used frequently and in a collaborative manner, laboratory researchers alter their R&D practices in light of newly considered socio-ethical aspects.

To take stock of the emerging field of socio-technical integration, Fisher organized the inaugural Communities of Integration (CoI) workshop at ASU in May 2013. This brought together seven distinctive socio-technical integration projects. Participants assessed the state of their research and compared the goals, methods, and assumptions of each approach.

The second CoI workshop is being held at the University of Waterloo this June.

Advancing the Field of Socio-Technical Integration

Dr. Fisher leads STIR as well as the CNS-ASU Real-Time Technology Assessment (RTTA 4) thrust, which aims to understand the dynamics of nanoscale science and engineering (NSE) laboratories through ethnographic and other methods. He is also an associate editor for the Journal of Responsible Innovation.

Dr. Fisher presented to the President’s Bioethics Commission on how including ethicists on a research team might affect change in scientific research decisions and under what conditions socio-technical integration generates productive interdisciplinary collaboration.

Video of the meeting and Fisher’s testimony may be viewed at http://www.tvworldwide.com/events/bioethics/140210/
An NSF Graduate Research Fellow at Georgia Tech and collaborator with CNS-ASU, Thomas Woodson’s research explores inequality in nanomedicine research and the role of public-private partnerships (PPP) in addressing health inequality.

He has found that some PPPs oppose the use of nanomedicine for treating diseases of poverty (DOP) because the cost of the technology prohibits the medicine from reaching the market in developing countries fast enough. They argue instead for directing R & D dollars to more mainstream technologies to treat DOP.

Through his collaboration with CNS-ASU, Woodson has presented his work on nanotechnology equity and equality at the Society for the Social Studies of Science Meeting in Denmark and the Universidade Federal do Parana in Brazil, among other conferences and workshops.

“CNS, and TRC 1 in particular, has been invaluable for my training and development as a scholar,” says Woodson. “I learned a variety of research techniques and worked alongside senior scholars. One of the things that excites me about CNS is that our work clearly impacts development and poverty around the world.”

Woodson has accepted an assistant professor position in the Department of Technology and Society at Stony Brook University, where he will study the intersection of technology and society at regional and global levels.

Thomas Woodson is an NSF Graduate Research Fellow at Georgia Tech. He has collaborated with Thematic Research Cluster (TRC 1) faculty at CNS-ASU. TRC 1 is co-led by Dr. Jameson Wetmore at ASU and Dr. Susan Cozzens at Georgia Tech and focuses on equity and equality of nanotechnologies.
Will resource-efficient corporate campuses provide gentrified and convenient places to work, live and play in Phoenix? Will alleys become zones for creative and communal encounters blending private and public space? Both futures are plausible given Phoenix’s historical and emerging socio-technical trajectories.

Visualized scenarios offer a way to imagine how a city’s future might play out – here supported by information collected in the Nanotechnology in City Environments (NICE) database (http://nice.asu.edu/) and by design proposals that cohesively captures the technical, cultural, and aesthetic influences acting on a city.

The product of a unique collaboration between CNS-ASU and ASU’s Design School, contrasting scenarios offer imaginaries of the interplay between emerging technologies and the environmental, economic, and social fabric of the city. Scenarios also provide a way to consider how current R&D, policy decisions, and public deliberations influence future urban landscapes and social dynamics.

Dr. Arnim Wiek and his team conduct research in the Thematic Research Cluster (TRC 2) on Urban Design, Materials, and the Built Environment. The group addresses the question: How can nanotechnology be innovated and governed in responsible ways and with sustainable outcomes? They employ system analysis, scenario construction, assessment, and intervention research methods to explore theories of anticipatory governance, sustainability, and responsible innovation.

One scenario depicts the integration of work, live, and play on a corporate campus in a futuristic Phoenix.

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For the past two years, CNS-ASU has held the week-long CNS-ASU Winter School at Saguaro Lake Guest Ranch. Open to graduate students and recent PhDs, the school is designed to give participants an introduction to and practical experience with methods and theory employed by CNS-ASU faculty and associates. The curricular content and activities are designed around the CNS real-time technology assessments and the two thematic research clusters.

“What we learned here won't be something we just put on a shelf. Everything is useful for contributing to our careers, institutions or professional workplaces.”

--Daniel P. Miller
Project Manager with US DOD
PhD Student at Virginia Tech
2014 Winter School participant

“We looked at where social scientists can intervene or integrate into the development process and potentially change the trajectory of overall technological development.”

--Molly Hartzog Storment
PhD Student at North Carolina State
IGERT Fellow, Genetic Engineering & Society
2014 Winter School participant

Ample work time and breaks encourage participants to guide their individual learning experiences, and the informal school setting is ideal for promoting spontaneous productive and collegial conversations. CNS-ASU Winter School also offers mentoring sessions with faculty.

Dr. Ira Bennett (left) and Dr. Jameson Wetmore (right) lead CNS-ASU education and outreach efforts.
Talking about the social implications of science is somewhat of a departure—and a sometimes uncomfortable one—from traditional science museum content. To help facilitate this shift in museum education, CNS-ASU’s Education and Outreach team, in collaboration with the Nanoscale Informal Science Education Network (NISE Net, NSF #0940143), published Nanotechnology and Society: A Practical Guide to Engaging Museum Visitors in Conversations.

Conversations, in addition to the more conventional formats of lecture, demonstration and display, are encouraged for science museum education. From conversation tips to training agendas to improv games, the guide provides numerous practical resources for training museum staff on how to encourage meaningful conversations with visitors about nanotechnology and its future societal implications.

The guide focuses on using the “Three Big Ideas” of technology and society as a conversation framework:

1. Values shape technologies
2. Technologies affect social relationships
3. Technologies work because they’re part of systems

The guide aims to empower museum educators and visitors to explore how emerging nanotechnologies may affect their lives and society.

The guide is being used by numerous science museums across the country. The “Three Big Ideas” framework used in the guide is part of a museum staff training program developed by CNS-ASU staff. It can be viewed at Vimeo: http://vimeo.com/channels/nanoandsociety

Dr. Ira Bennett (left) and Dr. Jameson Wetmore (right) have been advising and collaborating with science museums and NISE Net on nano and society issues for several years. They lead the CNS-ASU education and outreach efforts.
In an effort to accelerate the formation of an international community of scholars and practitioners working to create a common concept of RI, CNS-ASU established the Virtual Network for Responsible Innovation (VIRI). Part of NSF’s initiative, “Science Across Virtual Institutes,” VIRI is led by CNS-ASU members David Guston and Erik Fisher and aims to facilitate worldwide collaboration among RI students and scholars and to incorporate ethics, responsibility, and sustainability into R & D.

Building a capacity to anticipate the challenges of innovation is one of the primary goals of CNS-ASU. To that end, CNS-ASU faculty led three efforts to coalesce an international community working to establish a common understanding of responsible innovation (RI) research, training, and outreach and to incorporate ethics, responsibility, and sustainability into R & D.

David Guston, together with VIRI colleagues, successfully proposed the Journal of Responsible Innovation to the British academic publishing house Taylor & Francis. The journal covers a wide range of RI topics and publishes traditional journal articles and research reports; pedagogical articles; and reviews, discussion papers, and perspectives on current political, technical, and cultural events. CNS-ASU director David Guston is the founding editor-in-chief, and CNS-ASU’s Erik Fisher is an associate editor. The inaugural issue, released in February, is available in its entirety at http://explore.tandfonline.com/cfp/est/tjri

Dr. David Guston is the director of CNS-ASU, co-director of the Consortium for Science, Policy and Outcomes (CSPO), and professor of politics and global studies at ASU. Dr. Erik Fisher is assistant professor in CSPO and the School of Politics and Global Studies at ASU.

David Guston led an international symposium, “Responsible Innovation in a Global Context,” at the AAAS 2014 conference. In addition to Dr. Erik Fisher, who directs the Socio-Technical Integration Research (STIR) project and leads RTTA 4 at CNS-ASU, the symposium included researchers from Brazil, Canada, Denmark, Japan, Norway, and the United Kingdom. They shared their experiences with defining and implementing responsible innovation in a variety of societal and political contexts.
Dr. David Guston is the director of the Center for Nanotechnology in Society at ASU. Dr. Guston is widely published and cited on research and development policy, technology assessment, public participation in science and technology, and the politics of science policy.

CNS-ASU’s central, strategic vision is “anticipatory governance,” or the capacity to manage emerging technologies before they become unmanageable. While many in the science and technology studies (STS) accept considerations of social responsibility and long-term outcomes as an essential part of the innovation process, other STS circles remain critical.

Much of critics’ resistance to anticipatory governance, David Guston asserts in the April 2014 issue of *Public Understanding of Science*. To that end, he reviews the public engagement activity and outcomes of the National Citizens’ Technology Forum on nanotechnology and human enhancement. He continues with a discussion of two spin-off activities—the Danish Board’s global engagement activity World Wide Views and the more concrete and experiential material deliberation activities of CNS-ASU.

He concludes that while engagement cannot overcome all of the challenges to democracy or for science, they do provide solid opportunities for intervention.

Moving citizens from understanding to engagement offers the opportunity to improve both democratic participation and scientific literacy, asserts David Guston in the January 2014 issue of *Public Understanding of Science*.


Dr. David Guston is the director of the Center for Nanotechnology in Society at ASU. Dr. Guston is widely published and cited on research and development policy, technology assessment, public participation in science and technology, and the politics of science policy.

InnovationSpace is a transdisciplinary education and research lab that seeks to teach students how to develop products that not only create market value, but also serve real societal needs while minimizing impacts on the environment. In the two-semester course for senior undergraduate students, interdisciplinary teams develop, test, and refine real-world product concepts for paying sponsors including Intel and Herman Miller.

Since 2006, CNS-ASU has supported the work of three teams annually. CNS-ASU faculty provide teams with professional and ethical guidance during all stages of product development to help them understand how the technology they incorporate functions in society and to encourage them to consider such ethical issues as sustainability, equity, and recyclability.

For more information on InnovationSpace, visit http://innovationspace.asu.edu.

CNS-ASU Provides Support and Ethical Guidance for InnovationSpace Students

The 2013-14 InnovationSpace is focused on products to solve childhood safety issues. One team is developing a force sensor to improve administering CPR to infants and young children.

The sensor rests on a child's chest during CPR and lets the user know whether he or she is applying appropriate force during CPR compressions. Nanosensors enable the force sensor to be small enough to avoid interfering with the CPR process, and piezoelectric materials eliminate the need for a battery, which could also interfere.

Team member Joleen Jansen, an ASU senior studying industrial design and design management, was chosen to represent ASU at the Industrial Designers Society of America (IDSA) Western District Conference, where she presented the CPR force sensor project. She was selected from among 11 western district representatives to present at the IDSA International Conference in August. Jansen and her team collaborated with Real-Time Technology Assessment (RTTA 3) faculty at CNS-ASU. RTTA 3 is co-led by Dr. Cynthia Selin at ASU and Dr. Kelly Campbell Rawlings at USC focuses on exploring plausible futures and elucidating public preferences about the future.
8. Strategic Research Plan

The long-term research goals of CNS-ASU are to demonstrate and refine the ability to perform RTTA and, in doing so, cultivate reflexivity and build the capacity for anticipatory governance in the NSE enterprise broadly conceived. By "reflexivity" we mean a capacity for social learning – by individuals, groups, institutions, and publics – in the NSE enterprise narrowly and society more broadly that expands the domain of and informs the available choices in decision making about nanotechnologies. By “anticipatory governance” we mean a broad-based capacity that extends through-out society that can collect, analyze, synthesize and interpret a wide range of information to manage emerging knowledge-based technologies while such management is still possible (Barben et al. 2008; Guston 2008; Karinen and Guston 2010; Guston 2010; Sarewitz 2011; Guston 2014).

In the nine years of the Center, we have demonstrated the ability to perform RTTA through the individually successful programs, the synergies among them, and the successful completion of the "end-to-end" activity related to TRC 2, Human Identity, Enhancement and Biology (Hays et al. 2012), which integrates those programs, along with the integrative research within TRC 1, Equity, Equality and Responsibility (Wetmore and Cozzens 2010) and the similar, integrative research in new TRC 2, Nano and the City. The ability to extend and refine RTTA required developing two related strengths: the connection among the Center’s programs in an ensemble, and the guiding role provided by the strategic vision of anticipatory governance – and its component capacities of foresight, engagement, and integration – for the research programs. The success of these efforts was greatly enhanced by our commitment to embark on empirical projects aimed at the Center's activities – in a reflexive mode of turning our methods on ourselves – to gather strategic intelligence. As described in the YR 4 and YR 5 annual reports, to facilitate the research ensemble, post-doctoral fellow Matt Harsh studied TRC 2’s end-to-end process and conveyed his findings to TRC 1. Also as described in the YR 4 and YR 5 annual reports, to strengthen the guiding role of anticipatory governance as the Center's strategic vision, we held a Visioning Workshop on futures of anticipatory governance (Selin 2008). We have continued this reflexive study in the recent year with the impacts-outcomes study, reported in RTTA 4, conducted by Michael Reinsborough.

With the “end-to-end” perspectives and the research ensembles firmly established, the new TRC 2 commenced in a nearly fully integrated manner, e.g., with RTTA 1 providing bibliometric and other data and for joint research with TRC 2, RTTA 2 incorporating questions dedicated to TRC 2 concerns into the public opinion survey fielded in the current year, RTTA 3 planning its major public engagement activity around city tours, RTTA 4 working together with TRC 2 an associated (unfunded) proposal to NSF for STIR City, and TRC 1 in essentially constant contact on issues of equity in urban sustainability. A recent change in team leadership – replacing Lim with Rawlings as co-leader of RTTA 3 – has allowed the retention of urban connections while introducing expertise in the study of capacity building. Moreover, TRC 2 has been highly integrated with engineering activities – particularly through a connection between post-doc Foley and CNS-FSE fellow Wender in Seager’s lab – leading not only to numerous joint publications but also to a greater emphasis in and new directions toward “anticipatory LCA” in the Seager lab and in the Quantum Energy and Sustainable Solar Technologies ERC that has been funding the rest of Wender’s work.

The Center’s Visioning Workshop contributed to strategic planning for education and outreach as well. With respect to education, the Center implemented its Winter School in Jan 13. Reviews provided by the early career participants were very strong, and the school continued with a second full cohort in Jan 14. For this cohort, we reduced somewhat the funds expended from CNS-ASU, requesting that participants contribute some funds from their institutions (almost all of the
domestically-based participants paid their own airfare). We will continue to wean participants progressively off of Center funding, aiming to establish a similar “pay-to-play” model that the Science Outside the Lab program developed.

CNS-ASU’s strategic partnership with NISE Net has continued to strengthen, resulting in the Center’s being named a “core partner” in NISE Net. After the nano mini exhibit and the collaborative work on training that resulted in the videos and face-to-face programs, CNS-ASU worked with NISE Net in the recent year to publish a printed guide to talking about societal issues in the museum context. CNS-ASU continues to make video communication an important focus of activities, and the Center has completed an overhaul of its website to show video, social media, etc., in a more attractive way. The Center’s commissioned short video, related to the Nano and the City and equity themes, was completed last year, and we are in discussion about how to use it to seed more active outreach around the question of where nanotechnology is in your day. The Center’s connection to filmmaker Regan Brashear reached fruition this year with the release of her film Fixed: The Science/Fiction of Human Enhancement, and the filmmaker Frank Theys continues to make progress toward his documentary on the STIR project. The short film derived from the design studio class and TRC 2 work has also received numerous viewings. The FutureTense documentary project is not dead but is significantly slowed due to funding challenges and “creative difficulties.”

CNS-ASU outreach to the private sector – strengthened under post-doctoral fellow Davies, who planned and conducted the Center's first Private Sector Engagement workshop in May 11 – continued with strong private sector engagement in TRC 2’s research activities, especially in developing the scenarios portrayed in the film about the future of Phoenix and the solicitation of comments back on it, and in RTTA 3’s conduct of the Futurescape City Tours. While outreach in Washington, DC has suffered some setbacks because federal budget difficulties have distracted potential congressional partners like the Congressional Nanotechnology Caucus, the Center has been active through C3PO’s Washington, DC office in hosting additional “New Tools” seminars by several CNS researchers. More on this collaboration, as well as video and private sector outreach, may be found in the Outreach section.

In the Center’s renewal review, site visitors asked about the apparent mismatch between the huge list of Center participants accounted for in Section 4, List of Center Participants and the List of Center Publications, which seems small in comparison. The response, which the committee found appropriate but which we reiterate here, is that as the largest center dedicated to the study of the societal aspects of nanotechnology in the country and, likely, in the world, CNS-ASU sees itself as an important producer of public goods like networking and infrastructure (capacity-building) – as a good hegemon, in other words. While we identified “growth” as an important strategic goal in our 08 Visioning Workshop, we also limited the size and number of our formal external collaborations (subcontracts) in our renewal. Yet, by accounting for the participants in our capacity-building activities, we can provide a transparent account of the reach the Center has had. This reach has included a vast number of international scholars and practitioners who have visited the Center in a way akin to a user facility in which the Center’s faculty, its conceptual tools, and its ongoing collaborations with scientists and engineers provide the infrastructure for work they cannot perform in their home institutions (see also Section 13, Shared and Other Experimental Facilities). Thus, the Center does not displace or dilute traditional deliverables like peer review with such activities but adds to them. The impacts and outcomes study should also provide some clearer insight into these issues.

CNS-ASU’s partnerships with scientists and engineers continue to thrive. At the undergraduate level, InnovationSpace stands as a unique example of cross-functional collaborations among design,
business and engineering. At the graduate level, we have transformed the PhD+ into a university-wide certificate program in Responsible Research and Innovation, and the training program in collaboration with ASU’s NNIN node is, along with the activities derived from CNS-ASU and elaborated and evaluated in the associated ESEE project, becoming a model for teaching societal and ethical implications (SEI) that was explored by more than 100 scholars at the SEI Congress, held at ASU in Nov 11 and co-sponsored by CNS-ASU. The associated STIR project is consolidating its findings, and an expansion of the STIR protocol that links embedded research activities through a more widespread network of sites to sustainable solar technologies has been introduced into a collaborative IGERT, the Solar Utilization Network, at ASU. The Center’s collaboration with Honsberg’s NSF-funded Quantum Energy and Sustainable Solar Technologies (QESST) ERC has continued, highlighted by CNS-Fulton School of Engineering graduate fellow Ben Wender’s research on “anticipatory life cycle assessment” at the interface of the two centers. The Center also collaborated with Panchanathan’s IGERT on Person-Centered Technologies and Practices for Persons with Disabilities (Miller is co-PI). With these awards, and the new award to Westerhoff from EPA on nano life cycle, CNS-ASU is partner to more than $30M in science and engineering funding at ASU. Outside of ASU, the Center received, in collaboration with Notre Dame, a small workshop award on the anticipatory governance of active nano-materials and nano-systems with CNS-UCSB and the two Centers for Environmental Implications of Nanotechnology at UCLA and at Duke. The Center took a hiatus from co-sponsoring the future-oriented Emerge workshop in the current year, but continues to support the Governing Emerging Technologies – Law, Ethics and Policy symposium, organized by Marchant in ASU’s Sandra Day O’Connor School of Law.

In looking beyond the Center’s ten-year funding from NSF, Guston and Fisher received in Oct 13 the $500K “Virtual Institute for Responsible Innovation” (VIRI) under NSF’s Science Across Virtual Institutes program. While VIRI would allow the persistence and extension of some of the core research activities of CNS-ASU – particularly a vision of responsible innovation that embraces anticipatory governance – it would also allow its international network of collaborators to continue and expand. Selin is also pursuing an opportunity to continue and extend the Center’s anticipation and deliberation activities through a Futures Initiative that may be sponsored by ASU’s Global Institute for Sustainability (GIOS). Recently, she and Sarewitz have been granted $100K in seed funding to co-design an initiative within GIOS to amplify and mobilize future-oriented research and practice. The resulting proposal will be eligible for a multi-year award of several hundreds of thousands of dollars.

More significantly for the persistence of many of our educational innovations, however, is the prospect of the Next Generation – National Nanotechnology Infrastructure Network (NG-NNIN). Associate director for outreach Wetmore had been tapped by Stanford University, which led the incumbent proposal in the NNIN recompete, to be its coordinator for social and ethical implications, with Bennett as his associate. If successful, the next generation NNIN’s SEI component, estimated at about $600K per year, would have included many of the formal and informal educational components that CNS-ASU has pioneered and extended them across the more than one dozen participating universities. However, NSF decided to make no award and instead provide some bridge funding and hold a new competition in a year or so.

More importantly still is an effort that PI Guston and senior investigator Sarewitz – as co-directors of CSPO – have been charged to begin by ASU President Michael Crow. Since opening at ASU in 2004, CSPO has been a research center that has also participated significantly in curricular activities – and CNS has been its largest project and test-bed. Following preliminary discussions with Crow and Provost Rob Page in Sp 14, Sarewitz and Guston have commenced planning for a reorganization of CSPO into a university-wide institute, a degree-granting and tenure-holding
graduate school, and a broader array centers in addition to CNS held in consortium as the new “Consortium for Science, Policy and Outcomes.” The relationship between this prospective change and CNS-ASU is terrifically important, as many people and activities initially associated with the Center will find a more permanent home in the new school. The school may be the tenure home of CNS-related faculty Guston, Sarewitz, Miller, Wetmore, Fisher and Selin, and it will also house the doctoral and master’s programs that CNS influenced, and the certificate program it helped create. Second, the institute and the expanded capacity at CSPO will help extend the Center’s emphasis on responsible innovation and anticipatory governance to new audiences at ASU and beyond. Planned partnerships with non-US institutions (Sussex, UCL) will revolve in part around themes of innovation, responsibility and sustainability – themes that CNS has made significant efforts to articulate through its current TRCs – and consolidated in the VIRI.
9. Research Program, Accomplishments, and Plans

RTTA 1: Research and Innovation Systems Analysis (RISA)

Personnel – faculty and senior participants

Jan Youtie (Georgia Tech, principal researcher, Enterprise Innovation Institute and adjunct associate professor of Public Policy) (team co-leader; GT Co-PI; CNS-ASU Co-PI)
Jose Lobo (ASU, associate research professor, School of Human Evolution and Social Change) (team co-leader)

Alan Porter (Georgia Tech, professor emeritus, ISYE and Public Policy)
Juan Rogers (Georgia Tech, associate professor, Public Policy)
Philip Shapira, (Georgia Tech, professor, Public Policy) (GT PI)
Deborah Strumsky (University of North Carolina, Charlotte, assistant professor, Geography)

Other Personnel: graduate students (4), undergraduate students (2), visiting scholars (3)
Graduate students: Sanjay Arora (Public Policy), Yin Li (Public Policy), Stephen Carley (Public Policy, PhD, December 2013)
Undergraduates: JJ O'Brien (Public Policy), Sahra Jabbehdar (Public Policy)
Visiting Scholars: Xiao Zhou (Beijing Institute of Technology, Management), Jing Ma (Beijing Institute of Technology, Management), Arho Suominen (Senior Scientist, VTT Technical Research Centre of Finland)

Goals: The overarching goal of RTTA 1/RISA is to characterize the technical scope and dynamics of the NSE enterprise and the linkages between it and a variety of public values and outcomes. A major research theme – RTTA 1/1: Organization, Structure, and Trajectories of Emerging Nanoscience – characterizes the NSE enterprise and its dynamics through data-mining techniques such as bibliometric and patent analysis, as well as through text-mining, interviews, and other methods. The strategic areas of emphasis are: the organization, structure and trajectories of emerging nanoscience and nanotechnology enterprise and application. A second major activity – RTTA 1/2: Nanotechnology Enterprise and Applications – develops real-time strategic intelligence about nanotechnology commercialization in the US and globally, through methods including those above but also through the creation of a corporate panel data set.

Research Accomplishments and Plans, RTTA 1/1

RTTA 1/1 Organization, Structure, and Trajectories of Emerging Nanoscience originally constructed a large-scale set of global databases of nanotechnology research publication records comprised of 1.6 million articles including more than 1.1 million from the Web of Science’s Science Citation Index (SCI) covering the period 1990-2013. In addition to the publication dataset, we also have developed a patent database that includes 90,000 nanotechnology patent documents (from 71 patent offices worldwide including USPTO, EPO, WIPO, Chinese State Patent Office) and 91 countries covering the 1990-2011 (January) time period.

The database originates out of a two-stage bibliometric search method that was developed and published in Porter, Youtie, Shapira, Schoeneck (2008) and updated in Arora, Porter, Youtie, Shapira (2013). This method is emerging as a public tool that other research groups are using or adapting. The former article describing the database has attracted 231 citations in Google Scholar (as of March 10, 2014) and 101 citations in the Web of Science. Researchers associated with the
Euro Nano Observatory compared six search approaches in preparation for its research monitoring activities and found that five of the six, including our approach, converge on a similar definition (Huang et al. 2008). As a result, the Euro Nano Observatory (a Framework Programme 7 project involving 16 partners from 10 European nations; see http://www.observatory-nano.eu/project/) is following our search approach as its benchmark for monitoring nanotechnology R&D.

A major effort in YR 9 is a review of trends in nanotechnology research and innovation systems in light of changes to the emerging nanotechnology domain. We submitted a paper, published in the Journal of Nanoparticle Research that used network analysis over three time periods to examine the emergence of a collectively shared vocabulary in nanotechnology.

A second major effort involved the development of an enhanced “map of patents.” This patent mapping approach considers how patents cite one another may help researchers better understand the relationships between technologies – and how they may come together to spur disruptive new areas of innovation. A base map comprised of 466 re-constituted patent classes grouped into 35 factors forms a base map and nanotechnology-publications are overlaid to show areas of technological distance and similarity. This work was cited by NSF’s Science 360 and on the front page of nsf.gov, MIT Technology Review, WIRED UK (“InfoPorn”), esciencenews.com, newswise.com, eurekalert.com, R&D Magazine, space-travel.com, livemint.com, futurity.org, interdisciplinarityscience.net, pcb007.com, circuitnet.com, entrepreneur.com, reuters.com.

Selected findings from this research in the reporting year include:

In examining the emergence of a shared nanotechnology lexicon, we found that (1) nano-prefixed terms moved from accounting for fewer than 20% of articles in the early 1990s to accounting for 80% of articles by 2010, (2) nano-prefixed terms has moved from comprising a network that is densely organized around a few common nano-prefixed terms such as “nanostructure” in 2000 to becoming less dense and more differentiated in using additional nano-prefixed terms while continuing to coalesce around the common nano-prefixed terms by 2010 (Figure represents keyword group co-occurrence map, 2010, top map zooms on the dense center of the 1,447 groups and 7,200 edges in the bottom map) and (3) the share of nanotechnology papers oriented toward biomedical and clinical medicine applications has risen from just over 5 % to more
than 11% (Arora, Youtie, Carley, Porter, Shapira 2014).

- Eighty-five percent of patent maps cross administrative boundaries. Graphene is primarily concentration in the metals and semiconductor area of the map (Kay, Newman, Youtie, Porter, Rafols, 2014).
- Graphene applications involve companies that specialize in the technology and those who offer a wider range of applications (Arora, Ma, Gao, Shapira, Youtie 2013).
- The building construction sector could benefit greatly from manufactured nanotechnology products, but although awareness of these products is higher than expected, adoption of these products is limited by issues around the applicability of these products to project-based outcomes (Arora, Foley, Youtie, Shapira, Wiek, 2014).
- Green nanotechnology patents have the same number of inventors as the average green patent, but more claims, more citations, and more technology codes and thus may be more “inventive” or “novel” (Lobo and Strumsky in preparation).

Several new research papers are in the pipeline, including:

- The share of publications in the active nanotechnology and beyond domain has increased modestly, suggesting that a portion of nanotechnology research and patents are engaged in next generation R&D (Suominen, Li, Shapira, Youtie, in process).
- Social science research in the nanotechnology domain has risen by more than an order of magnitude from 2008 to 2012 (Carley, Youtie, Shapira, Porter, in process).
- Nanotechnology publications with authors from university, industry, and government organizations have greater value than those with less diverse sectoral participation, controlling for discipline, total number of publications, and other factors (Carley, in process).
- China surpasses the US in publications by 2010 and in citations by 2013 (Li, Arora, Youtie, Shapira, in process for the PCAST review of the National Nanotechnology Initiative). One explanation of the rise in China’s citations is that there is a clubbing effect, where leading scientists in China reference one another’s work (Tang, Youtie, Shapira, under review).
- Nano-enabled drug delivery has multiple pathways for innovation (Porter et al, in process).
- Preliminary work is underway on synthetic biology, including the development datasets of scientific publications excerpted from the Science Citation Index, and relevant publications in the social sciences and humanities.

Research Program, Accomplishments, and Plans, RTTA 1/2

One activity of RTTA 1/2 is the creation of a corporate panel of nanotechnology corporate enterprises. A corporate panel is a set of corporate enterprises which have “entered” nanotechnology as evidenced by a nanotechnology publication authored or co-authored by an individual in a corporate enterprise and/or a nanotechnology patent assigned to a corporate entity. The notion behind the corporate panel is to track changes in panel companies nanotechnology activities over time. We developed a database of 120,000 records (57,000 publications and 63,000 patents from 18,000 companies). This database was used to select the US portion of the corporate panel, which is comprised of 125 large US nanotechnology companies and 125 small and medium-sized US nanotechnology enterprises (SMEs). A large company is defined as one that is mentioned in the EU Industrial R&D Investment Scoreboard and the Global Forbes 2000. Our corporate panel includes 125 large US nanotechnology enterprises, which fall (based on their industry classification) into six different segments: (1) industrial equipment, (2) electronics/energy/ICT, (3) health/medicine, (4) materials/chemicals, (5) transportation/aerospace, and (6) food/other consumer. The panel also includes 125 SMEs which fall (based on their industry classification or
market offerings) into the first four segments; we did not find a sufficient number of SMEs in the latter two segments to populate them. These 250 large and small US nanotechnology enterprises have been matched with companies in the same segments outside the US.

This panel has been used to address research questions such as: (1) What kinds of linkages do these companies have with universities and other research institutions? (2) How is strategy for introduction of nanotechnology-enabled products and materials construed in the face of uncertainty? (3) Where do these companies and their products fit in the global supply chain and where is inventive activity geographically located? (4) What international boundaries are these supply chains crossing and what role do consumer values and demand play? Three publications in this line of research are:

- One in ten small and medium-sized nanotechnology firms are involved in a merger or acquisition; these mergers and acquisitions involving nanotechnology firms provide complementary capabilities and serve as an innovation source to larger acquiring companies (Youtie and Kay, 2014).
- Two different strategic approaches are employed by small and medium-sized enterprises to enter the domain of nanotechnology: an early-entry strategy is associated with nanotechnology research and discovery and possibly use of nanotechnologies to enhance properties of products; and a later-entry strategy associated with a strong focus on intensive patenting activity (Kay, Youtie, Shapira, 2013).
- A segment of small and medium-sized enterprises chooses to publish rather than patent in nanotechnology (Li, Youtie, Shapira, under review).

A second activity of RTTA 1/2 is characterizing the nature of the nanotechnology enterprise and its applications through patent analysis. A team consisting of new RTTA 1 co-leader Lobo at ASU and new other senior personnel Strumsky (at North Carolina, Charlotte) uses two new patent databases constructed with other NSF support – one on patent applications submitted to the U.S. Patent Office matched with granted patents, and the other a database on the technology codes used by the Patent Office to classify the technologies utilized by a patented invention – Lobo and Strumsky have calculated patent success rates and measured the technological complexity of nanotechnology patents. Results from this research, indicating that patent applications in the area of nanotechnology have a lower success rate than the norm and are more technologically complex than the average patent, were presented at the Transatlantic Conference on nanotechnology held at Georgia Tech in Mar 10.

Lobo and Strumsky have also examined the presence of nanotechnology in US patents classified as “green.” The classification of US patents as green is one that the research team has developed previously based on one produced by the Patent Office but augmented after discussions with personnel from the Patent Office, NSF, and the White House Office of Science and Technology Policy. The results from this work are included as part of a comprehensive report on the “Green Economy” which the Brookings Institution released in Jul 11 and a Brookings working paper on the “geography of green patenting.” Lobo and Strumsky are preparing a report on “How Green is Nano?” as a CNS-ASU report. Preliminary results indicate that green nanotechnology patents have the same number of inventors as the average green patent but more claims, more citations received, and more technology codes, suggesting that these patents are substantially more inventively novel than the average green patent.

Plans in this work involve the use of web-based sources such as company websites and social media. For example, we plan to assess the social networks that firms in the graphene domain acquire as a result of their participation in twitter.
Contributions to “ensemble-ization” or other center-wide activities.

RTTA 1/1’s co-authored publications with TRC 2 on drivers of adoption of manufactured nanotechnology products in the building construction industry began through a collaboration between doctoral students in RTTA 1/1 (Arora) and TRC 2 (Foley) at an CNS-ASU All Hands meeting in 2010. A presentation at the 2009 S.NET Conference workshop led to an article on environmental, health, and safety in nanotechnology published in 2011 which is co-authored with a CNS-ASU PhD+ graduate. This publication would have never been possible without access through CNS-ASU to the CNS-ASU graduate student who is a scientist in the nanotechnology environmental, health, and safety area.

In addition, there are several other activities to which RTTA 1/1 has contributed:

- RTTA 1/1’s organization of the EU-US Transatlantic Workshop on Nanotechnology Research and Innovation Policy included two researchers from CNS-ASU, including one from RTTA 3.
- RTTA 1/1’s co-authorship of a paper with RTTA 2, based on merging data from the scientists’ survey with information from the global nanotechnology publication database on the presence of nanotechnology environmental, health, and safety entries in the cited references of articles co-authored by these scientists, which appeared in Research Evaluation in 2011.
- RTTA 1/1 collaborated with a then CNS-ASU PhD+ graduate student on a paper examining nanotechnology environmental, health, and safety research and diffusion, which appeared in the Journal of Nanoscience and Nanotechnology in 2011.
- RTTA 1/1 researchers contributed 3 chapters to TRC 1-led Yearbook and provided bibliometric data for TRC 1 case studies;
- RTTA 1/2 is examining the “green” nature of nanotechnology applications in conjunction with TRC 2.

In addition, RTTA 1/1 (Shapira, Youtie) shared their publication and patent datasets with colleagues at CNS-Santa Barbara and attended the All Hands meeting for CNS-Santa Barbara, January 31-February 1, 2014 to share research directions and plans for joint research. RTTA 1/1 also co-developed and submitted a joint proposal to the NSF STS program; although the proposal was not funded, it did represent a productive collaboration.
RTTA 2: Public Opinion and Values

Personnel – faculty and senior participants

Dietram A. Scheufele, RTTA 2 co-leader (Wisconsin, John E. Ross Professor, Life Sciences Communication)
Elizabeth A. Corley, RTTA 2 co-leader (ASU, Associate Professor, School of Public Affairs)

Dominique Brossard (Wisconsin, Professor and Department Chair, Life Sciences Communication)
Michael A. Xenos (Wisconsin, Associate Professor and Department Chair, Communication Arts)

Other Personnel: post-docs (0), graduate students (9; 2 paid, 7 not), undergraduate students (0)

Goals: The overall goal of RTTA 2 POV is to monitor, among both the public and scientists, the understanding of and values relating to NSE and its potential societal outcomes, track these variables over time, and examine the role of the media in reflecting and influencing them. POV comprises a set of inter-related research themes around the public, NSE researchers, and the media. RTTA 2/1 Public Opinion Polling is the major project, conducting nation-wide public opinion polls to understand, at an aggregate level, the public’s knowledge of and values regarding nanotechnologies. RTTA 2/2 Scientists’ Opinions and Values is a research theme that conducts polls of NSE researchers to understand their perceptions and values regarding nanotechnologies. RTTA 2/3 Media Influence is a research theme that tracks media stories of nanotechnologies and, using a quasi-experimental design, attempts to understand how various media frames for nanotechnology stories can influence the knowledge and opinions of the public.

Research Accomplishments and Plans, RTTA 2/1

As part of the Public Opinion Polling research, Corley & Scheufele have capitalized on their experiences with some of the earliest public opinion surveys on NSE (e.g., Scheufele & Lewenstein, 2005) and have continued to develop and refine ways of measuring attitudes, information seeking, and policy stances. This methodological work is a necessary condition for doing sophisticated basic research. But it has also allowed the POV team to assist other researchers across the globe (e.g., Université de Caen Basse-Normandie, France; Poznan University of Economics, Poland; and Dublin City University, Ireland) by sharing instruments and expertise. During YR 9 of the CNS-ASU grant, the POV team has also been able to provide real-time feedback to policy makers when they need specific information about policy-relevant public attitudes.

RTTA 2/1 has completed two general, full-scale public opinion data collections: in Jul. 2007 and Jan. 2012 and is preparing to field an instrument that will collect data in Apr. 2014. The 2007 survey was a CATI survey with a combined RDD and listed household sample conducted May – Jul 07 (N=1,015; margin of error, +/- 3%). The 2012 survey was conducted by Knowledge Networks (N=2,806; margin of error, +/- 2%), and it embedded experimental manipulations into a nationally representative online survey. This new approach has three analytic advantages: First, it allows us to examine different subpopulations – serving goals of TRC 1 by including those that have been traditionally underserved by science communication efforts (defined by gender, age, ethnicity, or other factors). Second, the large sample is divided into three, nationally representative samples, each focused on a separate technology (nanotechnology, synthetic biology, and nuclear energy) to help us examine the processes of opinion formation and market dynamics surrounding nanotechnology in comparison to other technologies. Third, we embedded a series of experimental
Religiosity and Public Acceptance of Nanotechnology

As with many other political and scientific issues, citizens rely on cognitive shortcuts or heuristics to make sense of issues for which they have low levels of knowledge. These heuristics can include predispositional factors, such as ideological beliefs or value systems, and also short-term frames of reference provided by the media or other sources of information. By combining CNS-ASU public opinion survey data from the US with Eurobarometer surveys about public attitudes toward nanotechnology in Europe, Scheufele, Corley and colleagues (2009) concluded that respondents in the United States are significantly less likely to agree that nanotechnology is morally acceptable than respondents in many European countries. These moral views correlated directly with aggregate levels of religiosity in each country, even after controlling for national research productivity and measures of science performance for high-school students. Building from this work, the Jan. 2012 data collection examined how American audiences process moral vs. amoral media frames related to emerging technologies. Results from this project suggest that we may be witnessing both framing and boomerang effects depending on the degree to which media frames match value predispositions, including religiosity and political ideology.
RTTA 2/1 research on the change in nanotechnology knowledge among the public over time has generated some particularly important results for TRC 1 and outreach. In particular, Cacciatore, Scheufele, & Corley (forthcoming) found that there are widening gaps in knowledge about nanotechnology since 2004 between the least educated and most educated members of the US public. Americans with at least a college degree have shown an increase in understanding of the new technology, while knowledge about nanotechnology has declined over time for those with education levels of less than a high school diploma. Closing these informational gaps among public audiences is a necessity, especially in light of a US budget that has reduced spending for “educational and social dimensions” of nanotechnology in recent years. There is a real urgency to find ways of communicating effectively with all groups in society. Unless researchers find ways to close these learning gaps, we may create two classes of citizens – those who are able to make informed consumer and policy choices about these new technologies, and those who simply cannot. Cacciatore, Scheufele, & Corley also concluded that the Internet is one of the most effective methods in closing gaps and informing the less educated about nanotechnology.

Risk and Benefit Perceptions

RTTA 2/1 research has produced multiple, continuous streams of research that have contributed to the literature about how nanotechnology was covered in media and how audience characteristics interact with these messages to shape attitudes about nanotechnology. For example, Scheufele and colleagues (2007) demonstrated that nanoscientists are more optimistic than the public about the potential benefits of nanotechnology; however, for some issues related to the environmental and long-term health impacts of nanotechnology, nanoscientists were significantly more concerned than the public. Therefore, RTTA 2/1 researchers concluded that nanotechnology may be one of the first emerging technologies where researchers have observed this trend of scientists’ being more concerned about some risks than the public. Building on this research, more fine-grained analyses have shown that when making risk judgments, nanotechnology experts use trust in scientists to make decisions while the public uses religious beliefs as heuristic cues. Although deference to scientific authority, science media use, and trust in scientists shape perceived benefits in both scientists and the public, these heuristic cues influence public perception to a larger extent than experts’ perceptions.

RTTA 2/1 has also examined the changing nature of risk and benefit perceptions to conclude that as the field of nanotechnology matures, public opinion research focused on judgments about abstract risks and benefits, rather than attitudes toward specific applications, is less useful. Recent RTTA 2/1 research shows that individuals who associate nanotechnology with particular areas of application, such as the medical field, take risk perceptions much more into account when forming attitudes than respondents who do not make these mental connections. Therefore, the RTTA 2/1 research program increasingly focuses on assessing measurement tools for the field of public opinion about emerging technologies more broadly.

Research Accomplishments and Plans, RTTA 2/2

RTTA 2/2 has also completed two national-level nano-scientist surveys: in Jul 07 and Oct 11. The 2007 survey was a mail survey of leading US nano-scientists (N=363; AAPOR RR-3: 39.5%). The 2011 data collection was conducted as a mail survey of leading US nano-scientists (N=444; AAPOR RR-3: 31.6%). The content of the 2011 survey was slightly different from the 2007 survey by focusing on more granular perceptions about the risks and benefits of nanotechnology, nano-
regulation, nanotech worker safety issues, public engagement, and the ethics of nanotechnology laboratory practices. By combining funds from CNS-ASU and the Kellett mid-career award given to Scheufele at UW, we will be able to conduct an additional scientist survey in 2014. Planning for this survey will start during the summer.

**Risk, Benefits, and Regulation of Nanotechnology**

The RTTA 2 team considers regulation of nanotechnology to be an important area for study because even though there is a high degree of scientific uncertainty about the risks of nanotechnology, policy-making cannot be placed on hold until risk assessments are complete. In the absence of risk assessment data, decision makers often rely on scientists’ input about risks and regulation to make policy decisions. RTTA 2/2 research has shown that nanoscientists are more supportive of regulating nanotechnology when they perceive higher levels of risks; yet, their perceived benefits about nanotechnology do not significantly impact their support for nanotech regulation. The research also finds that male nanoscientists are less supportive of nanotech regulation than their female peers and materials scientists are more supportive of nanotechnology regulation than scientists in other fields.

In addition, Corley & Scheufele concluded that the leading U.S. nanoscientists see the areas of surveillance/privacy, human enhancement, medicine, and environment as the nanotech application areas that are most in need of new regulations. Based on the 2007 survey results, Corley, Scheufele and Ho (2009) found that in addition to risk perceptions, nano-scientists use their economic and social values to make decisions about nanotech regulation, and that surveillance/privacy, human enhancement, medicine, and the environment are the application areas in which nano-scientists see the greatest need for new nanotechnology regulations.

Also, Kim, Corley & Scheufele (2012) used the 2007 results to explore the perceptions of nano-scientists regarding the regulation of nanotechnology, with a particular focus on the governmental level (local, national, or international) at which the scientists believe nanotechnology regulation should be implemented. This regulatory discussion is important because international regulations are often difficult to adopt and implement; yet, local or state-level regulations could lead to the nanotechnology equivalent of the Pollution Haven Hypothesis (PHH). The results indicate that some scientists support local-level nano-regulations, but most scientists support the regulation of nanotech at the national or international level.

Kim, Corley & Scheufele (2012) found that there are three distinct categories of nano-scientists that have unique perspectives on regulation: “cautious innovators,” “nano-regulators,” and “technology optimists.” The “cautious innovators” are more supportive of implementing nano-regulations at the local level. Additionally, these scientists think that public opinion is more important than scientists’ opinions for research decision-making and that we depend too much on science and not enough on faith. This group is also more likely than their peers to support the regulations of academic nanotech research. The second group of scientists is the “nano-regulators.” These scientists are more likely to say that the government should protect the public from unknown nanotech risks. Also, these “nano-regulators” are more supportive than their peers of nano-regulations at the national and international level. Lastly, they are more likely to support the regulation of commercial nanotech research. While many scientists acknowledged the importance of nanoregulation, some scientists are less supportive of restricting nanotech advancements using regulations – i.e., the “technology optimists.” These scientists are more likely to think that advancing nanotechnology is more important than protecting society from the potential nano-risks. Also, these scientists tend to
think that scientists know best when it comes to making scientific decisions that can impact the public.

Perceptions of Media Coverage

Exploring public perceptions and scientists’ perceptions about media coverage of nanotechnology – as well as the public communication of research – were also key focal areas for the RTTA 2/2 team in the 2007 data. Using the 2007 survey results, Corley, Kim and Scheufele (2011) also explored leading U.S. nano-scientists’ perceptions about media coverage of nanotechnology and the public communication of research findings, concluding that leading U.S. nano-scientists perceive an important connection between the public communication of research findings and public attitudes about science. Additionally, there is a significant relationship between the scientists’ perceptions about media coverage and their views on the timing of public communication; scientists with positive attitudes about the media are more likely to support immediate public communication of research findings, while others believe that communication should take place only after research findings have been published through a peer-review process. In addition, leading U.S. nano-scientists tend to view media coverage of nanotechnology as less credible and less accurate than general science media coverage. These results indicate that leading U.S. nano-scientists do feel a sense of responsibility for communicating their research findings to the public, but attitudes about the timing and the pathway of that communication vary across the group.

An Updated View of Nanotech Regulation Perceptions

The RTTA 2/2 team is currently analyzing and publishing from the 2011 scientist survey. Corley & Scheufele recently published an article in a special issue of Review of Policy Research that uses the 2011 data to explore nano-scientist perceptions about existing nanotechnology policies, the development of new nanotech policies, levels of governmental regulation, current and future risk levels for public exposure to nanomaterials, we well as mandatory policies about the implementation of safe lab practices for federally funded nano-research.

Perceptions about Worker Safety, Gender, and Social Responsibility

In 2013, Corley, Kim & Scheufele analyzed the 2011 nanoscientist survey data to publish an up-to-date view of leading U.S. nanoscientists’ perceptions about the regulation of nanotechnology. In particular, this research explored the leading nano-scientists’ perceptions about existing nanotech policies, the development of new nanotech policies, and mandatory policies about the implementation of safe lab practices for federally funded nanoresearch. The conclusions of this research indicated that nanoscientists are more likely to say that commercial nanotech research should be regulated than academic nanotech research. Additionally, the leading U.S. nanoscientists believe that lab directors in both university and industry nanotech settings have a strong ethical obligation to protect their workers from unhealthy exposure to nanomaterials. In addition, many of the scientists believe that federal funding of nanotech research should be linked to formal guidelines that would protect workers from exposure to nanomaterials.

Research Accomplishments and Plans, RTTA 2/3
Finally, RTTA 2/3 continues to analyze media content in three different outlets. First, we continue to use the infrastructure built during the first five years of CNS-ASU funding to analyze in real time content data from small, medium-sized and large newspapers in the US. Papers from this work appeared in disciplinary journals (e.g., *Journalism & Mass Communication Quarterly*) and also in outlets specific to particular scientific fields (e.g., a piece on food nanotechnology in *Appetite*). Second, RTTA 2/3 partnered with the UW NSEC on Templated Synthesis and Assembly at the Nanoscale to purchase access to Crimson Hexagon. This software license allows us to analyze content streams in real time from all online and social media outlets (including Twitter, Facebook, blogs, online newspaper sites etc.). RTTA 2/3 continues to collect and mine data for traditional media, but our collaborations with the UW NSEC have allowed us to provide real-time insights into the ongoing debates around nano that are unique in the field of the social studies of science. An article comparing online and offline media environments was recently published in *New Media & Society*. Finally, students at UW have been using content analytic tools we built as part of CNS-ASU to branch out into other fields of research. Maria Stubbings worked on a content analysis of media coverage of gene patenting in the US; she defended this work in May of 2012. An article examining Twitter discussions surrounding nanotechnology was published in the *Journal of Nanoparticle Research*, and an analysis of social media content is included in Cacciatore’s dissertation project.

**Contributions to ensemble-ization or other Center-wide activities**

RTTA 2/2’s study of nanotechnology risk perceptions has led to collaborative work with RTTA 1 (specifically Youtie & Shapira) to better understand the relationship between societal perspectives held by nano-scientists and their publication actions (Youtie et al. 2011). This collaborative research between RTTA 1 and RTTA 2/2 has explored the relationship between scientists’ risk perceptions about nanotechnology and their actions in citing nanotechnology environmental, health, and safety (EHS) publications. RTTA 2 has also collaborated with the Social Implications of Nanotechnology Group, part of the University of Wisconsin Nanoscale Science and Engineering Center (NSEC). These collaborations can be seen in many of the publications and conference presentations noted below.

Wisconsin has also been working on assessing the impacts of CNS-ASU on broader public and policy discourses. This work takes advantage of research infrastructures we have been building over the last eight years – partly in collaboration with thr the UW Nanoscale Science and Engineering Center on Templated Synthesis and Assembly at the Nanoscale at UW-Madison (UW-NSEC) – for tracking media content, blog posts and communications on social media platforms (Twitter, Facebook, etc.).

Using these infrastructures, we have begun to track online (Runge et al., forthcoming) and offline (Choi, Dudo, & Scheufele, 2013; Dudo, Choi, & Scheufele, 2011; Dudo, Dunwoody, & Scheufele, 2011) discourses about nanotechnology, especially as they relate to CNS and CNS-related activities. We use three commercial software packages that allow us to track various forms of communications in real time. Using a combination of the Lexis Nexis (licenses through UW-Madison) and Vantage Point (licensed through CNS-ASU) software packages, we are able to extract large amounts of traditional media content into an electronic data base that allows us to content analyze it using computer-based or human coding. We will also use a collaborative agreement (funded partly through CNS-ASU and UW-NSEC) with Crimson Hexagon, a startup headed by Harvard’s Gary King, which gives us access to their software at a deeply discounted rate. Crimson Hexagon is a software that extracts linguistic patterns from small samples of online/social media content identified by human coders as being representative of particular types of content. It then develops generalizable algorithms from these patterns, and uses them to track the underlying content in every captured
Tweet, Facebook post, or blog. In other words, computer algorithms inductively determine the patterns of underlying content identified by human coders, and then apply the learned patterns for large scale data processing.

The combination of these different tools allows us to track all discourses surrounding nanotechnology in a comprehensive and real time fashion. In particular, we will be able to focus on our analyses on at least three different aspects.

First, we will continue to track the amount of coverage in traditional news channels and discussion on various online (social media) platforms. Second, will track the sentiment or types of discourses surrounding nanotechnology. This will focus on sentiments, such as expressions of uncertainty or the risks of benefits of nanotechnology, as they relate to nanotech more generally, but also to discussions or media coverage surrounding CNS more specifically. Do Tweets or blog posts surrounding CNS activities, for instance, reflect particular activities or aspects of CNS? Third, and most importantly, the comprehensive real-time tracking of online and offline content will also allow us to examine how (a) regional differences and (b) CNS activities – especially if coordinated across different sites – are received and multiplied by lay audiences and journalism in traditional media and through online channels. This particularly relevant since some of our initial research on Twitter suggests that even the presence of NSF-funded Nanoscale Engineering Centers (NSECs) in a specific state can significantly influence the amount of Twitter traffic in a region. Our analyses will expand on this idea and track online traffic surrounding particular sites, but also before and after events, such as Nano Days in collaboration with NISE Net or related coordinated events. We have completed preliminary analyses for Twitter and will soon move into the full analysis stage for all other areas.
RTTA 3: Anticipation and Deliberation

Personnel – faculty and senior participants

Cynthia Selin, RTTA 3 co-leader (ASU, assistant professor, CSPO, School of Sustainability)
Kelly Rawlings, RTTA 3 co-leader (ASU, assistant research professor, School of Public Affairs)

Prasad Boradkar (ASU, associate professor, School of Design)
Adelheid Fischer (ASU, Manager, InnovationSpace, School of Design)
Sidnee Peck (ASU, program manager, W.P. Carey School of Business)
Angela Pereira (European Commission, Joint Research Centre)
Roopali Phadke (associate professor, Macalester College)
Thad Miller (assistant professor, Portland State University)
Gretchen Gano, (lecturer and research fellow, Center for Public Policy and Administration, University of Massachusetts Amherst)
David Tomblin (Director of Science, Technology and Society Program at University of Maryland, College Park)
Kevin Jones (senior research scientist, University of Alberta)
Krista Harper (associate professor, Anthropology and Public Policy, Amherst College)

Other Personnel: Post-docs (2); grad students (3 at ASU; 8 at UMass; 3 at Macalester College; 4 at Virginia Tech; 1 at Macalester; 3 at Portland State University; 4 at Univ. of Alberta); undergraduates (9 in InnovationSpace at ASU; 1 at Macalester).

Goals: As a whole, RTTA 3 problematizes conventional deliberative approaches to anticipation that unreflexively predict technological outcomes. Instead, this research pursues anticipatory governance by honing in on future-oriented methods informed by plausibility (Selin 2011; Ramirez & Selin 2014) and drawing on STS perspectives path dependency, co-production and responsible innovation.

RTTA 3 consists of four tightly integrated approaches that address research, education, and outreach. RTTA 3/1 Futures of Foresight explores and assesses alternative approaches to imagining plausible nano-enabled futures. RTTA 3/2 InnovationSpace is a collaborative undergraduate design course among ASU’s Schools of Design, Engineering, and Business in which transdisciplinary teams of students create product designs, marketing plans, and engineering models of potential products within a framework of responsible innovation. This year’s focus is on children’s health and safety. RTTA 3/3 Probing Future-Oriented Deliberation is plans to probe in experimental settings the frameworks, inputs, structures and qualities of future-oriented deliberation. RTTA 3/4 Futurescape City Tours (FCT) builds on the foregoing to implement a large-scale citizen engagement activity that includes independent and joint deliberation of six groups of locally representative lay citizens from across the US on issues related to nanotechnology and the city.

The major focus for YR 9 is RTTA 3/4 with sustained support of InnovationSpace (3/2).

Research Accomplishments and Plans, RTTA 3/1

The Plausibility Project seeks to better understand the meaning and significance of the concept of plausibility through questioning the ways individuals and communities know, explore, assess and shape futures across time, cultures and professional practices. In YR 9, Selin and Angela Pereira of the Joint Research Centre of the European Commission, co-edited a special issue in the International Journal for Foresight and Innovation. In addition to the special issue, Selin and Rafael Ramirez of University of
Oxford completed an article on the etymological history of plausibility and its relevance for scenario planning for Foresight.

RTTA 3.1 explores and assesses alternative approaches to imagining plausible nano-enabled futures. In recent years, CNS-ASU researchers have honed in on the notion of ‘mediated futures’ to systematically account for practices of anticipation that capture the affective and sensual, moving beyond discursive representations of alternative futures (Davies et al 2013). CNS’s former post doctoral scholar Davies (now with University of Copenhagen) was in YR 9 awarded the prestigious Marie Curie Fellowship to pursue work on ‘making and hacking’ derived from RTTA 3.1 research.

In light of Selin’s sustained interest in Mediated Futures, she was invited in YR 9 to co-convene the Oxford Futures Forum, an international gathering of academics and practitioners focused on scenarios and anticipation. Since 2005, the Oxford Futures Forum (OFF) has enabled generative dialogue, productive collaboration and deep reflection on interdisciplinary concerns between two established communities of thought and practice, one the scenarios community and the second representing a theoretical perspective, which for the 2014 Forum is thinking, which builds on RTTA 3’s Emerge event (2012).

Research Accomplishments and Plans, RTTA 3/2

InnovationSpace is an entrepreneurial joint venture among the Herberger Institute for Design and the Arts, Ira A. Fulton Schools of Engineering, and W.P. Carey School of Business at Arizona State University. The goal of this transdisciplinary education and research lab is to teach students how to develop products that create market value while serving real societal needs and minimizing impacts on the environment. The two-semester InnovationSpace course satisfies the studio, capstone and thesis requirements for senior majors in each unit. In addition, many of the students are Barrett Honors College students and write their honors theses about their InnovationSpace work. In the course, cross-functional teams of students drawn from industrial design, visual communication design, business and engineering use a product-development model known as Integrated Innovation to research, develop, test and refine real-world product concepts for paying sponsors including, in recent years, CNS, Intel, Disney, and Herman Miller. Since 2006, CNS-ASU has supported the work of three transdisciplinary teams (a total of 12 students) annually.

CNS-ASU has partnered with InnovationSpace, led by Boradkar to investigate nano-based technologies that ensure the freedom, privacy and security of citizens (AY 06-07), to visualize socially beneficial opportunities for nanotechnology in the areas of human health and enhancement (AY 07-08), to develop product concepts that utilize nano-enhanced solutions for ensuring equitable access to clean energy (AY 08-09), to develop product concepts that utilize nano-enhanced solutions for addressing urban sustainability in relation to waste management, energy efficient transportation and energy awareness (AY 10-11), address public health with special emphasis on clean water, safety of emergency services, and drug abuse prevention, to address the problems of household and office waste, indoor pollution and the urban heat island effect (AY 12-13). This year, students are looking at child safety in urban environments, thus rounding out a comprehensive look at urban systems. Outcomes from InnovationSpace include not only invention disclosures made to AZTE (15 from previous years and three more expected this year), but also spectacularly detailed documentation of the student-led innovation process known as Innovation Proposals. These include summaries of user research, product renderings and prototypes, engineering specifications, branding and communication strategies, ecological impact assessments and business plans. Students in the program are also introduced to (often nano-related) concepts of biomimicry as a means of developing more environmentally-responsible product ideas, engineering solutions, business plans and brand strategies. CNS has
supported this activity by sharing examples of biomimetic design occurring at the nanoscale for the students to learn from and incorporate into their projects. In the coming year, Boradkar and colleagues from engineering will be submitting an NUE proposal to continue support of InnovationSpace’s work on nano-related products.

Research Accomplishments and Plans, RTTA 3/3

Emerge took place on the ASU campus 1-3 Mar 12 and brought together artists, scientists, engineers, students, and educators in an attempt to “redesign the future” by thinking critically about the future of emerging technologies. In YR 9, headway has been made on a special issue for Futures, led by Selin and slated for publication in 2014. Articles include different analyses of Emerge and feature articles by CNS’s Selin, Miller, and former post doc Davies, among others. In addition, the documentation of the Emerge workshops has been transformed to a custom designed online platform for open access annotation and curation (http://emergedata.vpl.design.cmu.edu) by Carnegie Melon’s Aisling Kelliher (formerly at ASU’s AME). Kelliher, who co-curated the Emerge exhibit at the ASU Art Museum with Selin in 2012, has also, since being exposed to the foundational ideas of RTTA 3/3, initiated a praxis-based course called “Design Fiction and Imagined Futures.”

Research Accomplishments and Plans, RTTA 3/4

Research and practice around innovative forms of public engagement with technoscience have been a key component of RTTA 3. Futurescape City Tours (FCT) is a distributed, deliberative activity that expands on the successes of the NCTF by increasing the experiential richness and contextual relevance of the deliberative process. Specifically, CNS-ASU researchers are investigating how to move “beyond discourse” within deliberation so as to incorporate the material, visual, and affective. These ideas have been discussed at a theoretical level in two recent papers (Davies and Selin 2012; Davies et al 2012), CNS-ASU is working on operationalizing this thinking into public engagement deliberative practices.

Using multi-media, reflective writing, and a walking tour, the FCT investigates how citizens can explore their local surroundings, visualize how these might change as a result of nanotechnologies, and deliberate about technological choices, preferences, complexities, and outcomes. The FCT’s methods prioritize citizen-driven agendas, the importance of place and materiality, the relevance of multiple timescapes through the creative use of multi-media tools. In addition to new tools, the FCT integrated stakeholders and S & T experts into the deliberation process.

In YR 9, the Futurescape City Tours brought engaged 108 citizens in six cities to discuss the implications of nanotechnology for the city thus a space for deliberation enabling small groups of participants to interrogate the directions such technologies are taking in their cities. The citizen groups were composed of engineers working with nanotechnology directly, stakeholders from the community, or those members of the public who have interest in the directions of science and technology for their city. The project leaders designed an experiential interaction and assorted conversation spaces that focused on nanotechnology and other emerging technologies and their connection to urban landscapes and sustainability, using techniques that began with citizen concerns and curiosities, rather than starting with a focus on technological promises and risks. One aim of the project, as with many CNS projects, is to amplify citizens’ skills to engage with complex technological subjects and to develop and articulate their own views on the desirability and implications of sustainability and nanotechnology.

Overall, the Futurescape City Tours seek to: 1) understand how new methods of public engagement work and with what consequences; 2) engage citizens in critical reflection about the risks and benefits of
nanotechnology for the city; and 3) better understand the notion of capacity building in the context of CNS’s vision of anticipatory governance.

In Spring of 2013, CNS researchers recruited six social science researchers from different regions in North America to scale up the FCT from the 2012 Phoenix Pilot. As a research group, the faculty involved collectively has a depth of experience in public and civic engagement, sustainability science, expertise, science communication and participatory technology assessment and together formed a well-functioning research collaborative. In May 13, CNS sponsored a three-day training session to relay, discuss and refine the FCT methods and theoretical positioning, which drew on the detailed theoretical and methodological explanations of the FCT presented on a shared research website (http://cns.asu.edu/fct/tour-implementation/session-iii).

In Fall 13, six FCT tours were implemented in six different cities. Each city followed the same methodology, with only minor modifications to suit local conditions. Each research site collected specified data that are shared in a data repository designed for the FCT and designed by Gano. The FCT started with an orientation session that aimed to establish citizen-set agendas regarding curiosities and concerns about emerging technology and the urban environment. The citizen group played the Nano Around the World game co-developed by CNS researchers and NISE Net, and afterwards they were provided with background material that included many of the research and media products developed by CNS. From the interests articulated by the citizens, CNS researchers then designed a walking tour of the city where participants were invited to use cameras and reflective writing to document, observe, question, and point out the places in their city where they see the past persisting, the present embodied, and the future emerging. Along the way, they met with a variety of scientific experts and civic stakeholders to discuss their concerns and question the role of technology in the city. In the third session, the citizens deliberated using their photographs to relay their views. Many of the sites completed the engagement with a gallery exhibition of the citizens’ images, inviting the citizens, as well as the experts and other stakeholders involved in the project, for further interaction.

An important feature of the tour is the varied interaction that the citizens have with community leaders, prominent stakeholders and scientific experts. Rather than follow a deficit model of public understanding of science, the FCT sought to connect citizens and others in dialogue through a number of formats. Across the sites, citizens visited labs, maker spaces, and heating and cooling facilities, among others, and had the opportunity to pose questions, initiate discussions and offer their critiques, hopes and fears to the engineers, policy makers, or scientific guides specially invited to interact with the citizens at each location. To take one example, in Springfield, citizens met with US Representative Richard Neal (D-MA), Daniel LaDuke, Energy Engineer for Conservation and Load Management at the Western Massachusetts Electric Company; Carolyn Hart Lucien of the Pioneer Valley Transit Authority, and Guy McLain, Director of the Lyman and Merrie Wood Museum of Springfield History. They also met with Ken Carter of the UMass Amherst polymer science and engineering department and Materials Research Science and Engineering Center (MRSEC) to learn about research in nanotechnology self assembly and roll to roll processing, and Nikhil Malvankar, a postdoctoral research associate at UMass Amherst in Derek Lovely’s Microbiology Lab, to learn about new bioenergy research associated with the Geobacter bacteria.

To implement the tours, and cinch the process into the local community, the sites rallied local resources and connections. For instance, at the DC FCT site, additional funding was secured from the Department of Science, Technology and Society at Virginia Tech ($2,000) and the CSPO DC office provided logistical support and a site for the first and third sessions of the project. Personnel at the National Building Museum helped design the DC tour and gave participants free admission to the museum on the day of the tour. At the Portland site, the Oregon Museum of Science and Industry (OMSI) provided space, free of
charge, for the first and third sessions and the Institute for Sustainable Solutions (PSU) provided funding for student support for the tour.

In January of 2014, as part of the CNS Winter School, the FCT partners met to discuss and develop ideas coming out of the FCT, coordinate analysis (as relevant), discover collaborative writing opportunities, identify publishing strategies and plan a communications and outreach strategy. We laid out joint papers and presentations, identified platforms for coordinating analysis, analyzed thematic overlaps between the citizens’ concerns, and developed near term plans for outreach. For the remainder of 2014, CNS researchers and FCT research partners are analyzing the results of the 2013 national Tours to demonstrate how the method works to build capacities among participants to appreciate the trade-offs, path dependencies and choices surrounding nano and their city.
RTTA 4: Reflexivity and Integration

Personnel – faculty and senior participants

Erik Fisher RTTA 4 leader (ASU, assistant professor, Political Science and CSPO)
Elizabeth Corley RTTA 4 co-leader (ASU, associate professor, Public Affairs)
Ira Bennett (ASU, assistant research professor, CSPO)
Steven Flipse (TU Delft, assistant professor, Communications)
David H. Guston (ASU, professor, School of Politics and Global Studies, CSPO)
Tom Seager (ASU, associate professor, School of Sustainable Engineering and the Built Environment)

Other Personnel: graduate students (20), post-doc (1)

Goals: RTTA 4/1 documents the influence of CNS-ASU research and engagement activities on the knowledge, values, and choices of NSE researchers and others. RTTA 4/2 theorizes and informs the integrative agenda of anticipatory governance through field research, methodological refinement and collaborative inquiry with NSE researchers. RTTA 4/3 implements the integrative agenda of anticipatory governance through interactions and collaborations with NSE and co-curricular activities including the DC Summer Session. RTTA 4/4 studies the meaning and implementation of integration and reflexivity in the sphere of science policy.

Projects under the RTTA 4 rubric include: interviews with and surveys of Center participants including collaborating NSE researchers, including the supplement awarded in YR 8 to study the impacts and outcomes of CNS-ASU activities; 30 laboratory engagement studies coordinated by the associated STIR project; and various projects that characterize, map and assess the integration of societal dimensions into NSE research and policy.

Research Program, Accomplishments and Plans, RTTA 4/1: Center Assessments

In previous years, we documented and assessed the influence of Center activities on the NSE researchers with whom we collaborate by annually implementing an interview protocol focused on the knowledge, identity, and practices of these NSE researchers, particularly around their understanding of the societal aspects of their work. In Fa 12, we transitioned to a much broader survey that now includes not only NSE researcher but all Center participants. This transition involved hiring postdoc Michael Reinsborough to assist Guston, Corley and Fisher in performing an impact assessment that surveys all Center (N=798) participants and includes follow-up interviews.

Measuring Impacts and Outcomes of a Large-scale Social Science Research Center

Traditional metrics for university research (e.g., publication counts, citation analysis) tend to demonstrate the extent of research impact only with respect to the immediate research community. While CNS-ASU performs well under such metrics, these means fail to account for other more diverse Center impacts that may play out across the broader community of publics who engaged with the Center. These impacts can take the form of learning and behavior (Guston, 1999) and can be theorized to take place within the Center’s Knowledge Value Collective (KVC; Bozeman, 2007)
Under supplementary NSF grant #0937591, RTTA 4 researchers set out to measure impacts and outcomes of the entire Center and at the same time explore possible experimental metrics suitable for assessing impact on the numerous and diverse communities which CNS-ASU interacts. The research was divided into two phases of data collection and then analysis and documentation:

- Initially an experimental survey was developed to explore quantitative measures of self-reported impact and outcome data from Center participants (N=798).
- From respondents a group of volunteers were generated for follow-up interviews (N=80).
- Survey data and the interview results are in the process of being analyzed and two papers are being prepared for submission to journals. Preliminary findings from the survey are summarized below.

**Data Collection.** In Apr 13, a survey on impacts and outcomes of CNS-ASU was distributed using Qualtrics software. Respondents had a period of 4½ weeks to reply, after which most US-based non-respondents were sent a printed version of the survey. The survey was developed using Dillman’s Tailored Design Method (Dillman, et al. 2008), emphasizing survey response as a social exchange within a community (rather than a cost/benefit economic exchange). The survey design prioritized a fuller range of expression for respondents over limiting respondent choice into easily analyzable but narrow categories. In part this choice was made because the broad range of CNS-ASU participants did not fit into one or two simple categories. Participants included graduate and undergraduate students, post-doctoral scholars, adjunct and tenure-track and tenured faculty from numerous academic disciplines that spanned the humanities, arts and social sciences and the various science and engineering disciplines. A variety of participants external to university research and teaching communities also included informal science educators, business and industry representatives, civil society and policy agents, and members of the media or the general public. Questions were asked about concept familiarity; skills and method use; CNS impacts and outcomes knowledge; societal, technical, public engagement, and reflexive learning about nanotechnology. Self-reported role was compared to administrative knowledge of participant role. The results were formatted to be analyzable using SPSS 21, statistical analysis software. From May-Dec 13, 80 follow-up interviews were conducted to explore in detail the nature and quality of Center impacts and outcomes. Volunteers for interview were generated from survey respondents. Interviews were transcribed in preparation for analysis using NVIVO software for textual coding and qualitative analysis.

**Data Analysis.** While findings from the interview analysis are not yet available, preliminary findings from the survey are summarized as follows:

- **Preliminary Finding 1:** The Survey had a high response rate (51.31%) and was reasonably well distributed among the various groups/subpopulations within the overall CNS-ASU participant population. A high response rate indicates a high interest in the work of CNS by participants.
- **Preliminary Finding 2:** CNS-ASU influence on the use of concepts by respondents (collective mean “partly” to “very much”) was greater than influence on the use of skills and methods (collective mean “little” to “partly”). This shows that (although some participants such as graduate students and post-doctoral scholars were formally trained in skills/methods) a large part of the Center’s activity related to concept work circulated outside the immediate trainee community. The concept with the highest
influence rating was “anticipatory Governance,” which is a signature concept of the Center.

- **Preliminary Finding 3:** Successively more persons are aware of the differing types of research impact, when impact type is arranged from formal to informal, from specific to general. A diverse typology of impacts/outcomes was used to more accurately capture some of the types of influences social science research centers can realistically have. Survey participants were asked to consider impact in a continuum from influencing an institution’s “authoritative decision” or changing its customary behavior to changes in vocabulary, agendas, or general thinking. In most cases the influences upon and reasons for an authoritative decision of an institution are available only to a few persons. Nonetheless, about 5% of the respondents were aware of the Center’s influence upon an authoritative decision of an institution, even though it is not the formal purpose of an NSF funded research center to seek impacts on institutional decisions. The steady increase in number of participants aware of each new type in the successively arranged typology of outcomes/impacts provides empirical support for this understanding of impact/outcome types.

- **Preliminary finding 4:** The primary goal of the Center is to engage participants in learning about the societal aspects of nanotechnology. For 392 respondents, the average self-reported learning rating was between “some” and “a lot.” There were differences in learning by constituency. The “Museums and Science Educators” constituency reported the highest amount of learning. Because there are relatively few public venues for mass science and society communication, the Center chose early to allocate resources and strategic emphasis on working with informal science communicators. A secondary effect of the Center is often to educate participants on the scientific and technical aspects of nanotechnology. Constituencies that reported this type of learning even included the “Science and Engineering” constituency (although as might be expected, NSE professionals showed slightly less learning than other constituencies in this learning category). Reflexive learning is key to understanding how publics/others engage with scientific knowledge and thus how science policy can better support participatory and deliberative democracy for decision making in a society where science and technology have tremendous impacts. Nonetheless, it is a very difficult both to explain and to measure such learning in a formal questionnaire. The mean self-reported learning about self and others (reflexivity) from all survey respondents was just below “some.”

The findings of the survey will be cross analyzed with the qualitative interview data to provide a more in-depth understanding of these results. Not only has this research project begun to assess the nature and quality of CNS-ASU impacts and outcomes, it has also used CNS-ASU as a laboratory to explore alternative metrics for large-scale social science research center assessment.
Research Program, Accomplishments and Plans, RTTA 4/2: Socio-Technical Integration Research (STIR)

CNS-ASU supports a unique set of laboratory studies and engagements. These studies are not traditional laboratory ethnographies with a focus on observation and explication, but rather are efforts to integrate social science and humanities with NSE research and to understand that integration. Early Center reports detail initial individual integrative research, and the Education section of this report discusses integrative curricular and educational activities. Since Sp 09, the separately funded NSF Socio-Technical Integration Research project (STIR; # 0849101; Fisher, PI; Guston, Co-PI) has constituted the Center's principle research activities focused on documenting and understanding NSE capacities to participate in responsible innovation through collaborative social scientific engagement. STIR has trained and coordinated the "laboratory engagement studies" (Fisher, 2007) of over two-dozen doctoral students, who implement a "decision protocol" (ibid.) that is designed to both facilitate collaborative "midstream modulation" (Fisher et al., 2006) and improve understanding of the conditions and capacities for "socio-technical integration" (as defined by Fisher & Miracle, in press; see RTTA 4/4).

As STIR director, Fisher has coordinated a set of thirty comparative, international, intervention-oriented lab studies in North America, Western Europe, and East Asia. To date the project has mentored and trained twenty-two (22) graduate students or "STIRers”—including twenty (20) doctoral students and two (2) masters students. They are divided into a "core" group of ten original project investigators and twelve “associated” investigators who since joined the participatory research program. Four (4) postdocs have also worked on project-related research. (See Education section for a list of the 22 participating STIR students and 4 post-docs by institution) STIRers are trained to implement various tools and techniques developed by Fisher over the course of each 12-week study in the attempt to conduct socio-technical collaborations, study the social and cultural conditions that prohibit and enable them, and assess the policy and political relevance of their outcomes. STIR laboratory engagement studies have been completed in over half a dozen ASU laboratories and in 22 additional laboratories around the world, bringing the number of labs in the STIR network to 28. To date, 30 studies have been completed, not counting Fisher's 3 pilot studies or 6 studies by researchers outside the US cognizant of the STIR approach.

Major activities in YR 9 include an aggregated assessment of STIR laboratory engagement studies, individual laboratory engagement studies, a reflexive ethnography project, international workshops including the Communities of Integration meeting, and testimony before the President’s Bioethics Commission.

STIR Aggregated Outcomes Assessment

In YR 9, Fisher and TU Delft assistant professor (and STIR alum) Steven Flipse designed a survey to tabulate outcomes across the STIR studies and explore conditions for effective socio-technical integration. The survey explores relationships between use of the STIR decision protocol and midstream modulation outcomes (reflexivity, deliberation, and adjustments), relationships among these outcomes, and relationships between instrumental and normative values in the outcomes. The survey was emailed Jan 14 to 23 project participants, and follow-up requests for clarification and elaboration of survey responses were emailed to select respondents. To date, 19 responses have been received from 23
requests, yielding a preliminary response rate (82.6%). These 19 responses report on 28 laboratory engagement studies.

Preliminary analysis of the 28 studies suggests three categories of use of the STIR protocol, according to level of collaboration: frequent (N=12), infrequent (N=10) and little or none (N=7). Preliminary findings show that both frequent and infrequent collaborative use of the protocol consistently produces changes in reflexive awareness, value deliberations, and material adjustments. Frequent use of the protocol, however, produces reports of more numerous changes in reflexive awareness and of greater value diversity in deliberations and adjustments than does infrequent use (where value diversity refers to both instrumental and normative values were considered). By contrast, little or no collaborative use of the protocol produces some changes in reflexive awareness, few changes in value deliberations, and no changes in material adjustments.

These preliminary findings are consistent with published results of individual STIR studies (Calleja-Lopez and Fisher 2009; Conley, 2011; Fisher, 2007; Fisher, 2010; Fisher and Schuurbiers, 2013; Flipse, 2012, 2013; Fisher et al., 2010; Schuurbiers, 2011), which are strongly indicative of both the possibility and the utility of socio-technical integration through social science-natural science collaborations. They suggest that collaborative use of the STIR protocol in a frequent and intensive manner (over a 10-12 week period) is very likely to enhance the reflexive awareness, value deliberations, and material adjustments of participating scientists and engineers and thus to exercise capacities for responsible innovation. By comparison, when the protocol is used collaboratively in an infrequent but intensive manner (over a 6-12 week period), similar results, although less numerous and less diverse, are also very likely. Sustained interaction between the social and natural sciences by itself, however, does not appear to be sufficient to produce such effects, which are fewer or absent altogether in cases of sustained interaction but with little to no collaborative use of the protocol.

**Individual STIR studies**

In YR 9, in an article in *Technological Forecasting & Social Change*, Flipse et al. (2013) report on a comparative research study to assess the extent to which industrial R&D projects can be measurably improved through socio-technical integration. They employed the STIR approach to midstream modulation with a group of project leaders and measured changes in their projects’ performance using Key Performance Indicator (KPI) scores. Their results show that the integration of social and ethical aspects was not only perceived by participants to be functional and useful, it also measurably improved KPI scores.
Also in YR 9, Cecilie Glerup, whose visit to ASU we previously reported on, completed a laboratory engagement study in Copenhagen, Denmark, the second of her paired 6-week STIR studies. Similar to Fisher’s pilot study, Glerup’s use of the STIR protocol was not intended to change scientific practices per se. Rather, it was used as a specific qualitative method focused on how norms affect conduct in scientific work. Using the same way of interviewing at every encounter and asking for justifications for the very specific decisions made in relation to scientific work, proved to be an effective way of relating macro structures with everyday practices in the lab. Nevertheless, and also similar to Fisher’s pilot study, certain “unintended side-effects” regarding reflexive and responsive capacities were observed. Two of the scientists called the interviews “my therapy session,” a room to reflect and ponder on their ways to go about during their work. Some also reported that they had changed their attitudes and work strategies due to the semi-structured interactions. One of the Danish scientists, for instance, reported that he had always been very skeptical about the public’s involvement in decisions about plant GMO, but he had been increasingly convinced that, “if we cannot convince the public about we are doing, then perhaps we are not doing the right thing’ and he had now volunteered to do a couple of public engagement activities.” Meanwhile, one of the US scientists reported that he has optimized a dermatological treatment process by using another method that reduced processing time from 15 hours to 15 minutes—an outcome that is likely to lower consumer cost for the product when it becomes commercially available.

While the STIR protocol thus at times heightened the reflexive and responsive capacities of the scientists, one can argue that it always did so in a specific organizational context, where the existing organizational culture set limits and possibilities on how to reflect. An important finding, which needs to be developed further, is that the reflexivity heightening observed among individual scientists took place within cultural patterns that were already in place within the lab. The organizational morale—what was collectively thought to be
'good' or 'bad'—had a high level of influence on the scientists' imaginations of their social responsibility.

Also in YR 9, Cameron Keys, a graduate of ASU's Science Policy Master's program, completed his 12-week study in Tsukubu, Japan at the Advanced Nano Characterisation Center (ANCC), Sengen site of National Institute for Materials Science (NIMS). Keys reports that the STIR protocol was deployed on the lab floor immediately following a failed experiment to organize and accelerate evaluation of possible sources of error. Not only did this process yield value for the research progress, institutional pressures and social obligations were explicitly discussed as part of an important technical practice. Key's study coincided with a professional documentary film in which participating scientists and the STIR researcher discussed the feasibility of modulating the material and social outcomes of laboratory knowledge production through forms of laboratory engagement. This led to Keys co-organizing a three-day public event in Amsterdam, Netherlands with the film director, which brought participating STIR scientists from Japan and other neuroscientists together to discuss technical, social, and ethical aspects of laboratory research with live audiences at the Flemish Cultural Center of Amsterdam. Keys and the participating laboratory director have co-developed a working paper discussing the politics of public neuroscience research, which publication is designed around themes co-developed during STIR interviews and subsequent discussions. Like other STIRers, Keys maintains a productive relationship with the laboratory scientists who hosted him.

Finally, YR 9 also saw Miles Brundage, a fellow of the Solar Utilization Network (SUN) IGERT (#1144616; Wim Vermass, PI; Guston, co-PI), commence STIR "rotations" across a series of laboratories and other organizations that span university research, industrial development, and public use and regulation of nanotech-based research, focusing on the intersection of robotics and AI.

**STIR Reflexive Ethnography Project**

While the main focus of STIR is on the capacities and conditions of technical experts to engage in socio-technical integration, it also offers an opportunity to focus on the experience of social science and humanities investigators. As reported last year, Fisher and ASU doctoral student Brenda Trinidad administered an online survey to project investigators as part of a mediated reflexive ethnography of STIR investigators' experiences in conducting laboratory engagement studies as embedded scholars working side by side with natural scientists and engineers in pursuit of collaborative inquiry. The survey was based on six broad themes (difference, construction, transformation, conditions, relationships and identity). Follow-up interviews were then conducted with select respondents for elaboration and clarification of survey responses. In Y9, the results were summarized and presented at the STIR project's 5th workshop, *Recollecting and Recording Stories*, held in Tempe in May 13.

The workshop was also designed to provide the 11 participants concentrated, in depth reflection in a group setting of the STIR experience, guided by the survey themes. With a focus on generating and documenting stories and vignettes, various new techniques were introduced to spark individual and shared memories. Time was provided for writing and sharing memories, the discussion of which became a cross pollination of ideas, in some cases triggering previously forgotten memories. An online shared document was utilized for the stories generated from these exercises. Additionally, time was given to review
previously written papers to locate stories and vignettes within each, which were also added to the shared document. The STIR researchers were also able to simultaneously begin coding the vignettes against the survey themes, cross-checking interpretations and coding rationales along the way. Workshop participants also identified additional themes (e.g., failure/success, disappointments, expertise, resistance, isolation/community). ASU doctoral students Trinidad and Conley are consolidating and analyzing the data generated from the survey and workshop. A draft reflective ethnography paper will be presented at the Jun 14 YR 10 STIR project workshop to be held at Waterloo University.

Communities of Integration

The YR 9 STIR workshop was held in conjunction with workshops held by other “Communities of Integration,” including Studies in Expertise and Experience (Harry Collins and Rob Evans), Trading Zones (Mike Gorman), The Toolbox Project (Michael O’Rourke), Conation (Tom Seager) and Field Philosophy (Britt Holbrook). Fisher and Seager brought these communities together in a “super workshop” in order to define an emerging scholarly field and sketch an overarching research agenda based on its stocktaking of socio-technical integration forms, means and ends. In assembling and helping host this collaborative, international network of research communities studying various aspects of socio-technical integration (theory, practice, and evaluation), STIR and CNS-ASU thus served as catalysts for articulating and comparing integrative capacities among new groups of social science and humanities researchers that previously had little to no interaction with the Center and that extend throughout multiple domains of emerging science and technology. Organized around key questions, the meeting allowed participants to exchange and compare their conceptual, methodological and normative assumptions and commitments. A working group chaired by Fisher with the assistance of ASU doctoral student Kennedy generated an executive summary comparing the Communities of Practice for Socio-Technical Integration (CoPSI). Following the meeting, Seager, Fisher and participating communities presented together in a panel at the Science of Team Science meeting at Northwestern University in Jun 13, and Kennedy presented findings synthesized from the meeting at an inaugural global conference on Research Integration and Implementation at Australia National University in Sep 14. A comparative methodological paper on socio-technical integration will be presented at the 2nd annual Communities of Integration meeting at the University of Waterloo.

Presidents Bioethics Commission Testimony

In addition to papers on socio-technical integration by Flipse et al. (mentioned above) and Fisher and Miracle (mentioned below), and various book chapters (e.g., Fisher and Schuurbiers, 2013; Gorman et al., 2013), we note that work informed by the STIR project has been presented in several public forums focused on responsible innovation, including a AAAS session organized by Guston and Fisher’s keynote at a symposium on Responsible (Research and) Innovation in Osaka, Japan. Dissemination of STIR ideas and results has also continued to occur within formal policy advice settings. In Feb 13, Fisher addressed the President’s Commission for the Study of Bioethical Issues in Washington DC. At the commission, Fisher
participants in a panel titled “Implementation Strategies for Ethics Integration & Roundtable Discussion.” Drawing substantially on STIR outcomes and research into the conditions under which science and engineering research practices are responsive to socio-ethical concerns, Fisher discussed how the inclusion of an ethicist on a research team might affect scientific research and whether this model has generated productive collaboration among scholars.

STIR is co-funded for 5 years at $540,000 through several NSF programs: Science, Technology and Society; Biology and Society; Mathematical and Physical Sciences and Society; Science of Science and Innovation Policy; and Office of International Science and Engineering. Additionally, through an international network that PI Fisher has cultivated since joining CNS-ASU in Aug 06, STIR project collaborators have expended over $500,000 to support and continue the non-NSF funded aspects of the project, bringing the total project funding to over $1M (not including administrative and financial support from CNS-ASU).

Research Program, Accomplishments and Plans, RTTA 4/3: Integrative Co-curricular Activities

(See Education section for an account of the DC Summer Session and the Certificate in Responsible Innovation.)

Research Program, Accomplishments and Plans, RTTA 4/4: Integration Policy and Responsible Innovation Studies

RTTA 4/4 conducts a number of policy studies that characterize, map and assess “socio-technical integration” into nanotechnology R&D prioritization, allocation and delivery processes in the US and around the world.

Integration Policy Studies

Last year, we reported on a study of 2500 research solicitations that found evidence that the increasing policy emphasis on socio-technical integration in European R&D system is confirmed at the level of resource allocation. In YR 9, Fisher and Miracle go one step above resource allocation and evaluate research prioritization in the US and UK nanotechnology programs in the wake of novel policy initiatives for responsible innovation. The paper, in press at Science and Public Policy, finds that decision makers engaged in limited reflection upon societal considerations during priority setting and allocation, in large part due to preclusive institutional practices and to fears that such reflection may slow down research and development. The paper also provides the following general and succinct definition of socio-technical integration: “any process by which technical experts account for the societal dimensions of their work as an integral part of this work” Importantly, this definition applies not only to laboratory-level deliberation and engagement—but to all levels and forms of reflexive expertise.

Also in YR 9, Fisher and Rip (2013) provide an extensive account of international efforts aimed at responsible innovation in terms of a multi-level framework that takes into account multi-level dynamics such as alignments among authoritative decisions, strategic choices,
and micro-level scientific research practices.

**Responsible Innovation**

As reported above and previously, Fisher and Guston have been closely involved with activities and scholarly efforts organized around the nascent concept of Responsible Innovation in the US, UK, Europe and Japan (cf. Owen et al., 2012). In YR 9, the Virtual Institute for Responsible Innovation (VIRI; # 1257246; Guston, PI; Fisher, Co-PI) was created to accelerate the formation of a community of scholars and practitioners across geographical and political divides to develop a common concept of responsible innovation for research, training and outreach. The institute’s research agenda includes a focus on Responsible Innovation as a Social and Intellectual Movement. In Feb 14, VIRI director Guston organized a session at the 2013 Annual AAAS meeting on “Responsible Innovation in a Global Context” that brought several founding academic partners together.

Additionally, YR 9 saw the creation of the *Journal of Responsible Innovation* (Guston, editor in chief; Fisher and four European colleagues, associate editors) and the release of its first issue. *JRI* provides a forum for discussions of the normative assessment and governance of knowledge-based innovation.

**RTTA 4 Continuing Integrative Outcomes**

In addition to conducting ongoing integrative studies and engagements, RTTA 4 involves various socio-technical collaborations. Last year, we reported on Fisher and Woodbury’s collaboration on developing provocative scenarios of nanodiagnosics for theranostics medicine based on work done in the Woodbury lab (Fisher et al., 2012). As mentioned above, in YR 9, Fisher and Seager co-organized the first annual Communities of Integration meeting and participated in a Science of Team Science panel on the same theme. Also in YR 9, Keys and the laboratory director who hosted him developed a co-authored article on politics of public neuroscience research.
Contribution to “ensemble-ization” or other center-wide activities
RTTA 4 continues to work with RTTA 2 and 3 in several projects. As mentioned above, in YR 9, Keys continued his participation on location in Japan and the Netherlands in the filming of Theys’ documentary *Lab-life* and co-organized a public engagement event on neuroscience and ethics. Fisher and Guston are working with Brundage to incorporate STIR and midstream modulation activities into field sites that are intended to link together university, private, and government actors who are anticipated to be involved in the emergence of artificial intelligence / robotics trajectories. Fisher and Wiek explored and continue to develop ideas for combining STIR with the sustainability agenda, combining elements of RTTA 4 and 3. Three attendees at the YR 9 CNS Winter School have continued working with Fisher on new projects. Finally, Guston, Corley and Fisher continued working with Reinsborough on the Center impact assessment that combines efforts of RTTA 2 and 4.
TRC 1: Equity and Responsibility

Personnel – faculty and senior participants

Susan Cozzens, TRC 1 co-leader (GA Tech, professor, Public Policy, TPAC)
Jameson Wetmore, TRC 1 co-leader (ASU, Associate Professor, School of Evolution and Social Change, CSPO)

Matthew Harsh, Assistant Professor Concordia University
Ogundiran Soumonni,
Rodrigo Cortes, (Technology Management)

Other Personnel: graduate students (2)
Rafael Castillo
Thomas Woodson (funded through an NSF graduate research fellowship)

Goals: Over the past several years the TRC 1 team has been focused on determining whether and how nanotechnology can be used to help the disadvantaged. Much of this work has been centered on South African and US initiatives to develop “pro-poor” nanotechnology.

Research Accomplishments and Plans, TRC 1

Community Engagement Workshops

During this research, the TRC 1 team found several examples of attempts to create pro-poor technologies that struggled greatly or failed completely because the scholars involved did not understand the context of the depressed regions they were trying to improve. In a modest effort to help remedy that problem, for the last year TRC 1 has been creating a series of short workshops that introduce scientists and engineers who want to engage with the developing world to basic steps they should take early on to increase the possibilities for success. Currently preparations are being made to hold at least four iterations of the workshop. A few of its components were piloted at the CNS Winter School in January 2014. A full run was held in Atlanta with Georgia Tech engineering students in March. In April we will be running a week-long module in the South African Master’s Program in Nanotechnology, to be held at the University of the Western Cape. We’re also planning a two day version of the workshop for engineering students at Concordia University (Montreal) where TRC 1 team member and former postdoc Matthew Harsh is now an assistant professor. A fifth workshop may be held at ASU in fall 2014. The ultimate goal will be to find out what works and what doesn’t and package the workshop so that it can be administered beyond the initial programs.
Graduate Student Dissertation Projects

Most recently, Cozzens has been working with graduate student Rafael Castillo on an analysis of the impact of nanotechnology on employment, using U.S. publication and patent data and an input-output model of the U.S. economy.

Graduate student Thomas Woodson is in the late stages of his PhD at Georgia Tech on the role of public-private partnerships in nanomedicine. At the Atlanta Conference on Science, Technology and Innovation Policy he presented preliminary data and he won honorable mention on his poster. and has accepted an assistant professorship at Department of Technology and Society at SUNY Stony Brook.

TRC 1 graduate students have been very successful in landing faculty positions upon completion of their work with CNS-ASU and we look forward to continuing to collaborate with them. Graduate students Rodrigo Cortes and Ogundiran Soumonni both finished their dissertations over the past year. Cortes is co-directing a Masters Program in Technology Management from his position at the Universidad de Chile and Soumonni is at the University of Witwatersrand in Johannesburg, South Africa.

Nano Around the World Card Game Update

The Nano around the World card game continues to be used across the country and beyond. For instance, Mathew Harsh uses TRC1 material, including the nano card game, in his upper level undergraduate classes for engineers at Concordia (Impact of Technology on Society, ~110 students per semester). As a result of this teaching, he was nominated by his students for the Global Engineering Teaching Award which is sponsored by Engineers without Borders. The “You Decide” spin off of the game was sent to over 200 science centers as part of the 2014 Nanodays kit.

Technology in Developing Countries Spinoff Project

The TRC1 work on technology in developing countries, especially South Africa, has also helped to form the foundation for a 2 year NSF grant that was awarded in September 2013 to Wetmore (PI), Harsh (Co-PI), and CSPO professor of practice Gregg Zachary (Co-PI). This new grant, “Capacity Building in Computer Science as a Driver of Innovation,” seeks to understand how African computer scientists in Kenya and Uganda are developing uniquely African solutions to African problems. As opposed to some most scientific fields, computer science is a relatively cheap and accessible way for nations without a lot of money or scientific expertise to develop their own indigenous science and engineering programs. The team will be looking for ways that developing internal expertise might be more effective at solving problems than technology transfer from western countries.

Women in Science Spinoff Project

Matthew Harsh is also supervising a graduate student (Gita Ghiasi Hafezi) at Concordia University (Mechanical and Industrial Engineering) who is utilizing TRC 1 frameworks for her dissertation 'Women in science and technology: the case of pro-poor applications of nanotechnologies.' Hafezi travelled to Georgia Tech in September to work with Cozzens and her graduate students.
**TRC 2: Urban Design, Materials, and the Built Environment ("Nano and the City")**

**Personnel – faculty and senior participants**

Arnim Wieck, TRC 2 leader (ASU, assistant professor, School of Sustainability)
Sander van der Leeuw, TRC 2 co-leader (ASU, professor and Dean, School of Sustainability)
Darren Petrucci (ASU, professor of design)

**Other Personnel**: (1) Post-doctoral scholar, (1) graduate student, (2) undergraduate students

**Goals**: The TRC2 group at the Center for Nanotechnology in Society (CNS-ASU) is addressing the question: How can nanotechnology be innovated and governed in responsible ways and with sustainable outcomes? Our studies employ system analysis, scenario construction, assessment, and intervention research methods to further develop and apply theories of anticipatory governance, sustainability, and responsible innovation. We focus on metropolitan Phoenix, a top-thirty nanodistrict and a top-twenty innovation hub in the U.S.

**Research Accomplishments and Plans, TRC 2**

*How is nanotechnology currently innovated and governed in the urban environment?*

The city is a powerful organizing mechanism for nanotechnology innovation and governance. Case study research in metropolitan Phoenix finds the dominant actor groups are academic, industrial, and government funding agencies (triple helix), with loose ties to other actor groups, including media and diverse publics. This actor network is divided along product-sectors with few cross-sector linkages. The dominant objective of innovation is to deploy profitable commercial or military products. There is novelty in the products’ functionality, ranging from solar technology to personalized medicine; but there is little evidence that nanotechnology in Phoenix offers novelty in its innovation and governance processes. Actors, activities, as well as constraining and enabling factors, follow market-oriented or closed-collaboration (military) models of innovation and governance with little attention paid to adverse effects or broader public values.

*How well does the current governance and innovation regime perform against principles of risk, sustainable, and anticipatory governance (responsible innovation)?*

The innovation and governance process is predominantly profit-driven, with little to no regard to anticipating societal and environmental risks, or the disruptive power of technology. Lack of cross-sector linkages limits opportunities for collaboration, coordination, and joint learning. The actor network in Phoenix pays little attention to risk mitigating organizations (e.g., insurers, government regulators, NGOs). The nano-enhanced city may offer benefits to a privileged few. City officials, civil engineers, NGOs, and citizens, who participate in urban development, are unlikely to have the opportunity to deliberate on the effects of nanotechnologies before they become real. These characteristics stand in stark contrast to state-of-the-art governance theory in technology development.

*What could be future implications if the current innovation and governance regime continues, in contrast to alternative models?*

The results from a participatory scenario study suggest that the two dominant models of nanotechnology innovation and governance (market-oriented, and closed-collaboration military model) might amplify the lack of social cohesion, livelihood opportunities, as well as resource depletion and large-scale contami-
nation. Society might get further divided along people’s socio-economic status. Social tensions and outbursts of violence might be countered with even greater dominance, surveillance, and other control mechanisms (employing suitable nanotechnologies). In contrast, we explore governance models with high levels of public participation or open-source activities that could create a new ‘triple helix’ of innovation, linking public agencies, risk-mitigating actors, and civil society. Society might develop a unique practice of collectively addressing urban sustainability problems. This could lead to transformational solutions, including particular types of nanotechnologies that alleviate stresses on people, economy, and environment.

CNS-ASU Director Guston welcomes participants to the workshop on “Nano and the City: Future Scenarios of Nanotechnology Innovation”. Participants discussed variables and future projections that informed TRC 2 scenario narratives depicting nanotechnology innovation in 2050.

What are necessary changes to innovate and govern nanotechnology in responsible ways?

An initial intervention study demonstrates that it is critical to complement nanotechnology innovation with non-technical interventions. Nanotechnologies in the current governance regime have limited potential to positively affect urban sustainability challenges, such as water contamination, energy use, or childhood obesity. Embedded in more comprehensive transition strategies, however, they could play a critical role in making progress towards urban sustainability.

TRC 2 co-leader Wiek welcomes the participants and introduces the walking audits in front of the Gateway Community College to a ‘Collaborative On-site Technology Exploration’ that brought together a diversity of stakeholders to explore necessary changes to innovate and govern nanotechnology in responsible ways.
Nanotechnology in City Environments (NICE) Database

Continuing work begun in previous years, two undergraduate students and one graduate student under the direction of Wieck created data entries for the Nanotechnology in City Environments (NICE) database. The NICE database catalogues academic research, public reports, advertising materials, technical specification, and theorized implementation of nanotechnology captured in an urban context. The NICE database is an interactive catalogue of nanotechnology applications with particular attention being paid to functionality, mechanisms, potential benefits, potential hazards, urban domain, development stage, and substitution properties. The database has been used as a resource for CNS-ASU in multiple projects, including the FutureScape City Tours as a reference for partners and participants, for TRC2 scenario study and for an assessment of the current state of nanotechnology. The website is also available to interested scholars, professionals, and the general public. The number of unique visitors to the website has increased more than ten fold in the past year, from 1,174 between March 15, 2012 to March 15, 2013. In the past year that number jumped to 12,998 visits between March 16, 2013 to March 14, 2014. Visitors are logging in from over 1,000 cities around the world, including the U.S., India, United Kingdom, Iran, Taiwan, Brazil, China, Germany and Canada. The database has been continuously updated and built-out during this time period. (Also see Section 12 Outreach and Knowledge Transfer).

The map shows cities where unique visitors have logged into the www.nice.asu.edu website to view information on nanotechnology provided by TRC2. Bubble size is proportional to the number of visitors, scale at bottom. Image provided by Google analytics.

Future City Scenarios

Co-leader Wieck guided a design studio that explored the scenarios constructed by TRC2 in partnership with director Guston and senior participant Petrucci and ASU’s Design School. Graduate students developed urban design proposals and other imaginative concepts of the nano-enhanced city based on the scenarios and their components, including societal drivers, innovation models, nanotechnology applications, and urban sustainability challenges. The students reimagined the urban design impacts of
various types of nanotechnology. Place-specific renderings were overlaid with audio to create a ‘movie’ that visually depicts the mutual interactions between nanotechnology and society. Based on this work, a set of publications, presentations, and future citizen engagements are ongoing. Most recently, Petrucci and post-doctoral scholar Rider Foley presented the scenario movie at the Consortium for Science, Policy and Outcomes in Washington, DC. The seminar drew over forty science policy advisors including staffers on the House Committee on Science, Space, and Technology; guests from federal agencies and departments including the National Sciences Foundation, Department of Energy, Department of Defense, National Aeronautics and Space Administration; science policy organizations such as the National Academies of Science, American Chemical Society; and local academic institutions. The seminar’s guests were struck by the layers of complexity exhibited in the evocative visualizations, which broke the mold of communicating future scenarios through line graphs and data projections. The guests appreciated this approach to explore future scenarios and the discussion focused on the effects of grounding the scenarios in a locale with rich cultural and technological contexts.

Design students discuss first set of urban design proposals with CNS-ASU director Guston and instructors Darren Petrucci, Renata Hejduk, and Wieck in the Decision Theater.

Avenues for further investigation

Having explored how nanotechnology is currently innovated and governed in the urban environment, and how the current governance and innovation regimes do or do not align with principles of risk, sustainable, and anticipatory governance (responsible innovation), we continue to develop a research agenda around the question of how to better align the current state of nanotechnology innovation and governance with principles of responsible innovation and sustainability. We are using an intervention research framework to engage stakeholders in exploring alternative practices that are more conducive to responsible and sustainable innovation.

We have identified approximately 50 potential interventions, focusing on nanotechnology innovation and governance in metropolitan Phoenix, and some across the U.S. We are selecting a handful of interventions to pilot in participatory, real-world experiments. Our selection criteria include, among others: a link to at least one specific normative responsibility; an accessible partnership is available; the transformation potential is high. For example, in as part of a collaboration with Arizona State University’s Consortium for Science, Policy and Outcomes (CSPO), where CNS-ASU is based, we are evaluating the effects of an immersive educational program, Science Outside the Lab (SoTL). The SoTL program takes PhD students and candidates from across the physical and natural sciences and engineering to Washington, DC to meet with science policy advisors, lobbyists, decision-makers, business persons, and nongovernmental
organization representatives, introducing the participants to the pluralism of interests shaping science policy related to nanotechnology and other national interests. We hypothesize that, as an intervention, the SOtL program raises participants' awareness of the complexity of science policy, better equipping them, as potential future leaders of science policy and practice, to consider and account for the social implications of and forces affecting the development of emerging technologies.

Under the direction of Wiek post-doctoral scholar Foley is continuing to engage with organizations that comprise the innovation system in Phoenix. Workshops with the United State Green Building Council, Arizona Nanotechnology Cluster, and Arizona Technology Council are being planned to both communicate the research group's findings and to explore alternative approaches to responsibly and sustainably governing nanotechnology within an urban setting.

In addition to conducting these intervention research projects as part of the TRC2 team, we are crafting an innovation intervention research protocol for publication, along with a greater detail on several of the 50 projects, mentioned above, to facilitate the practice of this research by other responsible innovation research groups.

*Contributions to “ensemble-ization” or other center-wide activities*

Operating in a Center-wide fashion has been a goal of TRC 2 from its inception. Graduate student Arora (RTTA 1) and Foley, with support from co-leaders Youtie, Shapira and Wiek, completed a two-year study on nanotechnology in the construction sector, which was published in Technological Forecasting and Social Change in 2014. Further collaboration between Lobo (RTTA 1) and Foley revolve around nanotechnology patents issued in Arizona and qualitative narratives about innovation dynamics in Phoenix, which contributed in part to data for an article published by Foley and co-leader Wiek in Technology and Society. Foley, Bernstein, and Kim (RTTA 2) collaborated on a conference presentation at the May 2013 conference on the Governance of Emerging Technology. Bernstein, Foley and Bennett submitted that work for publication in the Journal of Nanoparticle Research. Wiek and Selin (RTTA 3) facilitated mutually supportive efforts to explore the future of Phoenix through the Futurescape City Tours and the Governance Scenarios of Phoenix in 2013. That effort was advanced through two published articles on the concept of plausibility in the International Journal of Foresight and Innovation Policy. In a joint effort to expand CNS’s capacity in Socio-technical Integration Research (STIR) and understand the dynamics of nanotechnology innovation in urban sustainability, co-leaders Wiek and Fisher (RTTA 4) are working with assistant professor Thad Miller at Portland State University (who also participated in RTTA 3 Futurescape City Tours) to submit a grant proposal for “STIR in the City.” To integrate and develop synergies between TRC 1 and TRC 2, graduate student Bernstein and co-leaders Wiek and Wetmore (TRC 1) are planning to collaborate on workshops that explore methods of training scientists and engineers on community-engaged innovation research. TRC 2 is successfully integrating research projects with CNS-Biodesign fellow Kalinowski, CNS-FSE fellow Wender, and engineering student Rushforth. These integrative efforts have resulted in five conference presentations, three peer-reviewed publications, and a chapter of Kalinowski’s dissertation entitled, “Facilitating Mutual Problem Understanding: Participatory Technology Assessment of an Emerging Technology.” Furthermore, graduate student Bernstein and co-leader Wiek are collaborating with the Education and Outreach team to evaluate the impacts of the “Science Outside the Lab” summer workshops in Washington, DC.
The Virtual Institute for Responsible Innovation (VIRI)

The Virtual Institute for Responsible Innovation (VIRI; cns.asu.edu) commenced as an associated project of CNS-ASU in Oct 2013 with a three-year, $500K award from NSF’s “Science Across Virtual Institutes” (SAVI) program. The scope of collaboration under VIRI includes not only CNS-ASU’s resources at ASU, Wisconsin, and Georgia Tech, but also centers of excellence at the University of Waterloo (Canada), University of Exeter (UK), Durham University (UK), University of Sussex (UK), Maastricht University (Netherlands), Karlsruhe Institute of Technology (Germany), Oslo and Akershus University College of Applied Sciences (Norway), State University of Campinas (Brazil), and the University of Copenhagen (Denmark). VIRI is considering the admission of additional members from the UK, Japan, France and elsewhere.

In its inaugural year, VIRI graduate research assistant Miles Brundage has investigated the ways in which responsible innovation (RI) fits the model of a scientific/intellectual movement proposed by Frickel & Gross (2005). He is in the process of interviewing two dozen scholars and policy-makers around the world about various aspects of their views and experiences related to responsible innovation. This work will help situate RI research and practice in a rigorous theoretical framework; identify commonalities and differences in how RI and related topics are seen around the world and in different institutional settings; and characterize some of the resistance to responsible innovation discourse/practice encountered by interviewees.

Brundage has also written and presented on connections between RI and the field of artificial intelligence. He presented a case for a more systematic approach to integrating social considerations into artificial intelligence research at the Philosophy and Theory of Artificial Intelligence conference at the University of Oxford. The paper is forthcoming in an edited volume with select papers from the conference. In addition to academic work, Brundage has also written for a public audience about issues related to artificial intelligence and its social implications for the Future Tense channel at Slate.com, a joint initiative of Slate, ASU, and the New America Foundation. He has also spoken about RI as a guest on a local radio station in Dallas and advised producers at several news outlets regarding the social implications of artificial intelligence.

In Dec 2013, VIRI co-PI Fisher and Brundage represented VIRI at an international symposium on responsible innovation in Osaka, the first such event in Japan. Fisher and Brundage exchanged ideas and experiences with researchers from Japan and around the world about science and technology governance. At the symposium, Fisher gave a presentation on "Socio-Technical Collaboration in Science: Building Capacities for Responsible Innovation," which highlighted his Socio-Technical Integration Research (STIR) project as well as VIRI and the Journal of Responsible Innovation, headquartered at ASU. While in Japan, Dr. Fisher also taught a class at the National Graduate Institute for Policy Studies in Tokyo and met with Japanese researchers in Tokyo and Kyoto. Meanwhile, Brundage met with researchers at artificial intelligence and robotics laboratories in Osaka and Kyoto to discuss RI.

In Feb 2014, VIRI PI Guston organized a 180-minute symposium, “Responsible Innovation in a Global Context,” at the annual meeting of the American Association for the Advancement of Science. The symposium featured VIRI participants Fern Wickson (Norway), Maja Horst (Denmark), Marco Markosy (Brazil) and Heather Douglas (Canada), as well as Michael Davis (Illinois Institute of Technology), Go Yoshizawa (Japan) and Fisher and Guston.

Other VIRI highlights include:
• PI Guston and VIRI partners Markosy (UNICAMP) and Macnaghten (Durham) contributed to the graduate course on responsible research and innovation that Bennett teaches at ASU;
• VIRI co-hosted with CNS-ASU a lecture on "An Institutionalist Sociology of Responsible Innovation" at ASU by Sally Randles (Manchester);
• VIRI partner Heather Douglas (Waterloo) delivered the 2013 Steinkraus Lecture on Human Ideals at SUNY-Oswego on the topic of the role of science in a democratic society;
• VIRI co-PI Fisher addressed the Presidential Commission for the Study of Bioethical Issues on 11 February 2014, discussing his work on socio-technical integration research and responsible innovation; and
• VIRI graduate research assistant Brundage and fellow doctoral student in ASU's Human and Social Dimensions of Science and Technology program Denise Baker have been selected to attend a summer school in Germany organized by the Notre Dame-led, NSF-funded EAGER/SAVI “Computer Architecture for 2020 and Beyond.”
<table>
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<th>(1) Current Year 9/15/13 - 9/14/14 Budget (NSF)</th>
<th>(2) Current Year 9/15/13 - 9/14/14 Budget (Cost-share)</th>
<th>(3) Current Year 9/15/13 - 9/14/14 Budget (Other Support)</th>
<th>(4) Summary 1-3 Current Year Total Budget (Combined)</th>
<th>(5) Next Year 9/15/14 - 9/14/15 Budget (NSF)</th>
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* Please note: Seed Projects have been included in the individual research program to which they are relevant.

David H. Guston, Director, CNS-ASU
April 14, 2014
10. NSEC Diversity Progress and Plans

Progress Toward Enhancing Diversity

Since its founding, the Center has worked to enhance the diversity of its leadership, faculty, postdoctoral, graduate, and undergraduate researchers. The Center has put significant effort into recruiting women and individuals from underrepresented groups. These efforts have included working with the ASU Hispanic Research Center to conduct workshops and courses oriented toward graduate and undergraduate students from underrepresented groups, as well as efforts to ensure appropriate advancement of faculty and postdoctoral researchers through promotion and increasing involvement in Center leadership. While the Center’s diversity has improved significantly since its inception, in the recent year there has been only a modest improvement in racial and ethnic diversity and a modest decrease in gender diversity overall (while gender diversity remains strong in leadership positions).

Center efforts have worked especially well in recruiting women into Center activities at all levels. NSECs are expected to be model programs and to meet or exceed national percentages for the inclusion of women and underrepresented groups in science and engineering. At all levels, the current percentage of women in the Center exceeds the relevant national equivalent percentage in science and engineering fields. The Center has also made progress with regard to Hispanic participation, especially in recent years. In terms of Center leadership, postdoctoral, and graduate student participation, the Center exceeds (and in some cases significantly exceeds) the national percentage for Hispanic teachers in colleges and universities. The percentage of graduate students from underrepresented groups also exceeds the percentage of doctoral degrees awarded nationally to students from under-represented groups. See Tables 4A and 4B for an overview of Center personnel. We report results for Table 3A and 4A, but percentages of US minorities tend to rise if Table 3B and 4B are used, as many reported Asian participants are not US citizens.

As directed by the NSEC diversity reporting requirements, we compare our data below with data from national science and engineering statistics, as provided by the National Science Foundation. For comparison, we have used data from NSF’s Women, Minorities, and Persons with Disabilities in Science and Engineering (http://www.nsf.gov/statistics/women/) updated January 2013 (with most data from 2010). The data available from this report is not symmetrical with respect to women and minorities nor the social sciences and science and engineering more broadly. We have therefore used the statistics available. Thus, our comparison categories vary somewhat.

Leadership: Center leadership has transitioned from its first phase (YRs 1-5) to its renewal phase (YRs 6-10). The Center’s leadership initially included two women of six principal investigators (Carlson, Schneider) and three women of eleven leaders of the six RTTA and TRC research programs (Corley, Hogle, Schneider), for a total of five of seventeen (29%). At the time of the YR 9 review, two women serve among the five renewal PIs (Corley, Youtie) and five women serve among twelve RTTA and TRC research program leaders (Corley, Cozzens, Rawlings, Selin, Youtie), for a total of five of fifteen Center leaders (33%). Of these individuals: Corley began as an assistant professor and faculty researcher and is now a tenured associate professor, research program leader, and co-PI; Cozzens began as a faculty researcher and is now a research leader; Selin began as a postdoctoral researcher and is now a tenure-track assistant professor, research program leader, and associate director for anticipation; Youtie began as a faculty researcher and is now a research program leader and co-PI. Rawlings joined the Center as a research professor and research program leader.
Research program leaders currently also include one Hispanic (Lobo), for a total of one of fifteen (7%) – an improvement over the lack of any members of underrepresented racial or ethnic groups among the original leadership team, but a drop from YR 8 with the departure of Lim from the Center's leadership team.

The percentage of women in Center leadership roles is equivalent the percentage of doctoral level women in US universities with very high research activity (33%, NSF Table 9-21). The Center's Hispanic leadership for the renewal period slightly exceeds the percentage of doctoral level Hispanics in US universities with high research activity (4%, NSF Table 9-21). For the social sciences specifically, these numbers across all US colleges and universities are 38% for women and 5% for Hispanics.

**Faculty and Professional Participants:** From YR 1 to YR 7, the Center increased the number (and percentage) of women faculty involved in Center research and activities (non-leadership) from an initial seven (7 of 31, 23%) to 194 (194 of 507, 38%) active faculty and professional collaborators. YR 8 and YR 9 participation rates were lower, as we did not co-sponsor three major conferences, as we had in YR 7. In YR 9, participation of faculty and professional participants was 207 total individuals, with 84 women (41%)

The Center has also increased the ethnic diversity of faculty and professionals involved in Center research (non-leadership). The Center faculty initially included 5 Asian Americans (of 31, 16%) and zero from underrepresented groups (of 31, 0%). The Center faculty and participants at the end of YR 7 included 2 Native Americans, 3 African Americans, 39 Asians, 9 Hispanic, and 1 disabled, for a total of 54 individuals (out of 507, 11%). In YR 8, participants included 1 Native American, 1 African American, 18 Asians, and 7 Hispanic, for a total of 27 (of 204, 13%), for an increase of 2%. In YR 9, participants included 1 Pacific Islander, 1 African American, 19 Asians, and 7 Hispanic totaling 21 (of 207, 14%) faculty and professionals.

Overall, the diversity of the Center faculty and professional participants stayed roughly the same in the past year. The percentage of women faculty in the Center slightly exceeds the percentage of women holding science, engineering, or health doctorates in US faculty positions in very high research activity universities (33%, see notes under Center leadership). The percentage of Hispanic faculty in the Center is slightly less than the percentage of Hispanic faculty according to the same metric (4%, see notes under Center leadership).

**Postdoctoral Researchers:** Since its inception, the Center has increased the diversity of women in postdoctoral research positions. Initially, the Center had one woman postdoctoral researcher (Selin) out of four (25%), who has subsequently been promoted to tenure-track assistant professor and has become a research program leader. By the reporting period of YR 9, the Center had 8 women (of 14, 57%). Center progress in enhancing the racial and ethnic diversity of its postdoctoral researchers has been somewhat but not fully satisfactory. The Center has increased the number of Asian and Asian American postdoctoral researchers involved in the Center, from one in its initial year (1 of 4, 25%) to 4 (of 14, 29%) in YR 9; the Center had 1 Hispanic postdocs (of 14, 7%). Unfortunately, the Center has not increased the number of African-American, Native American, or Pacific Islander postdoctoral researchers from its initial zero. The percentage of women postdoctoral researchers in the Center exceeds the percentage of women in postdoctoral positions in the social sciences (47%, NSF Table 8-1).

**Graduate Students:** The Center has seen significant progress since its inception in improving the gender, racial, and ethnic diversity of its graduate students. At its inception, among its active
graduate researchers, the Center had eight women graduate students (8 of 28, 29%) and eight Asian or Asian American graduate students (8 of 28, 29%). As of the YR 9 report (Table 4A), the Center has 44 women (of 88, 50%), 17 Asian or Asian American (of 83, 19%), one African American (of 88, 1%), and nine Hispanic (of 88, 10%) active graduate students among its researchers. In addition, Center degree programs and certificate / training programs (Table 3A) have involved 40 women (of 83, 48%), 1 African American (of 83, 1%), 16 Asians (83, 19%), and 9 Hispanic (of 83, 11%) students. These levels indicate increased participation from women and Hispanics from previous years and decreased participation from African Americans and Asians.

The percentage of women graduate students involved in Center research is marginally lower than the percentage of women graduate students in the social sciences nation-wide (54%, NSF Table 3-5). The percentage of under-represented minorities (26/83, 31%, Table 3A; 27/88, Table 4A), collectively, is above the share of under-represented minorities among social science graduate students nationally (22%, NSF Table 3-1).

Undergraduates: The Center has made some progress in improving the diversity of its undergraduate researchers. At its inception, the Center had two women undergraduate students (2 of 8, 25%), three Asian or Asian American undergraduates (3 of 8, 38%), and no other students from under-represented groups. In reporting YR 9 in its research programs (Table 4A), the Center has 7 women undergraduate students (of 22, 32%), 3 Asian (of 22, 14%), 1 African American (of 22, 5%), 1 Pacific Islander (of 22, 5%) and 4 Hispanic undergraduate students (of 22, 18%). Total minority undergraduates involved in research equaled 8 (of 22, 36%), an improvement in all categories and overall. Undergraduates involved in the Center’s educational programs (Table 3A) include 13 women (of 30, 43%) 1 African American (of 30, 3%), 4 Asians (of 30, 13%), and 3 Hispanics (of 30, 10%), for a total of 8 (of 30, 27%).

Plans Going Forward
While the Center has performed strongly on diversity during its first nine years, meeting and, in many cases, exceeding relevant national percentages, there are still opportunities in the remaining time of the Center to improve. We have therefore established a strategic plan for the renewal period on diversity that aims to further improve the Center’s diversity profile.

Overall Objectives: The Center’s overall objective with respect to diversity is to be a model for incorporating diversity among Center participants. To achieve this, we propose to pursue the following specific goals:

1. To maintain and continue to advance high levels of Center diversity in those areas documented above where Center diversity currently exceeds appropriate national levels;

2. To seek opportunities to recruit new Center participants, where appropriate, who will enhance the diversity of the Center in those areas where the Center is currently lower than appropriate national levels; and

3. To enhance graduate and undergraduate participation among students from underrepresented racial and ethnic groups.

Strategic Opportunities: Looking forward to the final year of the Center’s NSF-supported activities, we propose to focus on a small number of concentrated activities that we think will make a concrete difference in the short term to enhancing the Center’s diversity while laying important
infrastructural foundations for improving long-term diversity in the field.

1. Identify other areas of engagement beyond the Hispanic Research Center. The Center has had a relationship with the Hispanic Research Center (HRC) at ASU, through which the Center has built a growing number of contacts with students from African American and Hispanic backgrounds. In YR 7, CNS taught a 7-week course on nanotechnology in society (described in the Outreach section) to 12 ASU graduate students in the sciences and engineering from underrepresented backgrounds. The course was very successful, with several of the students following up and participating in Science Outside the Laboratory, Chemistry 501, led by Bennett and Wetmore, and other Center activities. In the reporting year, the major HRC STEM funding mechanism (the MGE@MSA program) sunset, leaving CNS-ASU without a major source of under-represented students for our programs.

2. The plan for YR 9 was to focus recruiting, funding, and other resources for the Winter School on students from underrepresented groups. Apparently we were unable to get that message to the right places as the under-represented minority applications did not materialize. In YR10 we will specifically target PhD students and post-docs at HBCUs and HSIs offering 3 full Winter School packages (including fees and transportation).

3. Develop and implement targeted recruiting efforts for the new Graduate Certificate in Responsible Research and Innovation and an undergraduate minor in Science & Technology Policy. We will organize and host recruiting events with HRC, American Indian Studies, and the American Indian Policy Institute, among others. We will coordinate diversity recruiting for the minor with the School of Public Affairs.

4. In YR 9, we successfully recruited in collaboration with the School of Social Transformation for a visiting assistant professor in science, technology, and social transformation. This person is teaching relevant courses in this area focusing on race and social justice around emerging energy technologies, which are strengthening recruiting into Center educational programs. In the coming year, she will be serving in Guston’s stead as the social scientist working with the SUN IGERT program.

5. In YR 9 we planned a small undergraduate research program for underrepresented minorities designed to provide students with research training and mentorship that will help prepare them for graduate school. Again, we had a hard time getting the message out. This year we intend to hold an essay competition for under represented minority ASU undergraduates in their sophomore or junior year. Scholarships will be awarded and recipients will be given priority consideration for CNS research internship positions.

6. We will set aside discretionary funds of $20k to support these activities.

Networking for Diversity: As part of its efforts, the Center has begun to develop networks of potential partners for enhancing Center diversity. In the upcoming year CNS will sponsor a series of workshops bring together representatives from the Community College and Tribal College system, Informal Science Education and industry groups that are interested in emerging technologies and education. Three workshops are planned: the first looking at lessons from nanotechnology education over the last decade, the second, looking at designing education for the next generation of scientists and engineers and third, the next generation of programming to engage and inform publics.
11. Education

CNS-ASU is involved in extensive formal and informal educational activities, from undergraduate curriculum to graduate student and post-doctoral training and mentoring, and from science and engineering practitioner training to collaborations with science museums. Many of these activities are tightly integrated with research and outreach activities, and most maintain as their central focus the building of broader societal capacity for anticipatory governance. Thanks to its many innovative programs, CNS-ASU is recognized as a national leader in two particular areas of education. First, building on activities like co-sponsoring the “Congress on Teaching the Social and Ethical Implications of Research” in Nov 2011, CNS-ASU is developing and promoting education programs that introduce science and engineering graduate students to the social implications of their work, as well as developing a community for the scholars that do this work. Second, through collaborations with the Nanoscale Informal Science Education Network (NISE Net), especially a new training program for museum, CNS-ASU is developing and promoting new ways to make the societal aspects of science and technology accessible to science museum audiences.

*Disseminating the CNS Education Models*

CNS is increasingly seen as a leader in educating scientists and engineers in the societal aspects of their work. In recent years, CNS scholars and educators have hosted visits and extended conversations about such interdisciplinary teaching and training with colleagues including Christine S. Jones (Colorado State University), Janet Kourany and Kathleen Eggleson (University of Notre Dame), Megan Palmer (SynBERC/Stanford), Mary Sunderland (Berkeley), and Erik Aarden (Aachen University/Harvard). Some of this work has been international, including a Sp 12, collaboration among TRC 2 co-leaders van der Leeuw and Wiek with six universities from Canada, Mexico, South Africa, Germany, Sweden, and Japan to disseminate the teaching and research of sustainability scientists across the globe and a Fa 10 UK ESRC funded trip by Edinburgh researchers Jane Calvert and Emma Frow to investigate the Center’s variety of training programs (followed up by subsequent visits by Guston in Fa 10 and Wetmore and Harsh in Su 11. Wetmore and Bennett also spent time at Edinburgh in 2012 disseminating CNS education programming and holding a workshop about science and society content in museums. Wetmore and Bennett were also involved in panels (at AAAS and 4S) that culminated, in collaboration with an NSF EESE grant (Herkert, PI), the National Nanotechnology Infrastructure Network, and NISE Net, in a Congress on Teaching the Social and Ethical Implications of Research. The response by the participants – more than 100 of them – was overwhelmingly positive, and the Center continues to contemplate how to bring the community together again.

*Post-doctoral training and junior research scholars*

CNS-ASU has put significant effort into building a cohort of talented junior scholars who are developing not only research skills but collaborative and leadership skills as well, including post-doctoral scholars in the reporting year Michael Reinsborough (PhD Belfast), Rider Foley (PhD ASU), and Kathryn de Ridder-Vignone (PhD Cornell). Researchers Barben (Free University-Berlin, Political Science & Sociology), Bennett (ASU, Chemistry), Conz (ASU, Sociology), Davies (Durham, Science Communication), Fisher (Colorado, Environmental Studies), Harsh (Edinburgh, STS), Selin (Copenhagen Business School, Knowledge & Management), and Wetmore (Cornell, STS) were all initially hired at the post-doctoral level
at ASU. Another postdoctoral researcher, Hannot Rodriguez-Zabaleta (Philosophy & Risk Assessment), joined ASU through an award from the Basque Government and has collaborated in Center research with Fisher. The Center has also provided training to post-doctoral fellows at the University of Georgia (Catherine Slade [Georgia State], under the direction of Bozeman on RTTA 1/2), Georgia Tech (Jue Wang [GA Tech], under the direction of Shapira on RTTA 1/1 and Sonia Gatchair [GA Tech], under the direction of Cozzens on TRC 1), and Wisconsin (Jason Delborne [Berkeley], under the direction of Kleinman on RTTA 3/4 and Ramya Rajagopalan [MIT], under the direction of Fujimura on former TRC 2).

Many of these scholars have made significant advances professionally and many have taken core leadership roles in CNS initiatives:

- de Ridder-Vignone has accepted a tenure-track offer at James Madison University in the Department of Integrated Science and Technology.
- Foley is interviewing at University of Virginia in the Department of Science, Technology and Society.
- Eight are now in tenured or track positions: Barben at Alpen-Adria-Universität Klagenfurt (Austria) in a tenured position; Wetmore, now tenured, at ASU in the School of Human Evolution and Social Change; Fisher in a track position at ASU in the School of Politics and Global Affairs; Delborne in a track position at North Carolina State University; Wang in a track position at Florida International University in Public Administration; Slade in a track position at the Hull College of Business at Augusta State University with an affiliation with the Medical College of Georgia; Selin in a track position shared between ASU’s School of Sustainability and the Consortium for Science, Policy and Outcomes; and Harsh in a track position at the Center for Engineering and Society at Concordia University.
- Bennett has been promoted into a research faculty position at ASU in CSPO.
- Conz was promoted into a research faculty position at ASU in CSPO, and also as a lecturer in ASU’s Bachelor of Interdisciplinary Studies program. He is now deceased.
- Gatchair is a lecturer at the University of the West Indies, Mona; Rajagopalan is a post-doctoral scholar at Wisconsin; Reinsborough is a post-doctoral research at King’s College, London (UK); Sarah Davies is a post-doctoral researcher at the University of Copenhagen (Denmark).
- Four have taken on formal leadership roles in the Center: Wetmore is currently a co-leader of TRC 1 and associate director for outreach, Fisher is currently a co-leader of RTTA 4 and associate director for integration, and Selin is a co-leader of RTTA 3 and associate director for anticipation. Bennett is assistant director for education and leads the DC Science Outside the Lab Policy Workshop.
- Three have obtained additional external support for CNS-associated activities:
  - Fisher is PI on the $540K socio-technical integration research (STIR) award, which extends the Center’s integration agenda that Fisher pioneered as a CNS-funded doctoral student at Colorado. Fisher was also PI on a National Nanotechnology Infrastructure Network (NNIN) award that seeks to “Document Integration” at several NSEC and NNIN sites.
  - Wetmore has been co-PI on three grants: a $300K NSF award from the Ethics Education in Science and Engineering (EESE) program that develops, teaches, and assesses several models of micro- and macro-ethics instructional activities for graduate students; a second $300K NSF award from the EESE program to develop CITI modules that address macroethics;
and a $700K NSF award to create and support a Professional Science Master’s Program in Solar Energy Engineering and Commercialization that has a substantial ethics and policy curriculum, work that is now led by Bennett. Wetmore is also PI on a recent $280K NSF award (with Harsh and Zachary), derived in part from TRC 1 fieldwork in Africa, on the emergence of computer science in Africa. He was also the social science lead for the NG-NNIN proposal led out of Stanford.

- Selin is co-PI on a recently awarded NUE with Seager and others ($200K) to investigate the societal aspects of nanotechnology through Lego serious play.

Many of the activities encompassed by these grants have roots in the Center’s program. Others are active in initiating and collaborating on new research proposals as well.

- Fisher and Selin are both collaborators on an $820,000 award from the Research Council of Norway to Norwegian researcher Roger Strand that incorporates intellectual approaches in integration and foresight that they, respectively, have pioneered.
- Several have been involved in editing the Center’s Yearbook of Nanotechnology in Society: Fisher, Selin and Wetmore (2008) edited the first volume. Wetmore edited the second volume (2011) with Cozzens, and Bennett edited the third volume with Hays, Robert and Miller (2012). Barben and de Ridder-Vignon are editing the fourth volume with Miller.

**Graduate Education and Training**

CNS-ASU organizes a variety of graduate education and training activities, aimed at several audiences. The first audience is the graduate students involved in the Center’s core research activities. While only some of these students have been directly supported in graduate assistantships by CNS, many others have drawn on CNS research to develop their theses, received CNS travel funds, and been involved in the Center’s events. In the reporting year, the Center has been training:

- At ASU, seven doctoral students:
  - Conley (Politics and Global Affairs), who defended her STIR-informed dissertation in Ap 14 and who has accepted a tenure-track offer from James Madison University;
  - Gano (HSD), who will be defending her dissertation Su 14, has been collaborating with Cobb at NCSU on a follow-on manuscript to the NCTF project, has been assisting ECAS in the World Wide Views on Biodiversity project and the NASA project, and who has an interview at Iowa State for a tenure-track position in science communication;
  - Trinidad (funded; HSD), who has been assisting both Fisher on RTTA 4 interviews and Wetmore and Bennett on the Informal Science Communication Program;
  - Luk (HSD), who has defended her dissertation in Sp 14;
  - Kim (funded; Public Affairs), who is completing his comprehensive exams and performing research for RTTA 2;
  - Sadowski (HSD), who has been working with Guston on the associated award, “Anticipatory Governance of Complex Engineered Nanomaterials;” and
  - Brundage (HSD), who is funded by the Virtual Institute for Responsible Innovation and serves as an editorial assistant for the Journal for Responsible
Innovation, and who is also affiliated with the Solar Utilization Network IGERT.

- Current updates on earlier ASU students include:
  - Foley completed his dissertation work in May 13 has continued on with CNS as a post-doc working on TRC 2 projects and helping run the Winter School. He has an interview for a tenure-track position at University of Virginia.
  - Pirtle, who completed his undergraduate degrees in mechanical engineering and philosophy in May 09, a master’s degree in civil and environmental engineering in May 10, and served a Fulbright Fellowship in Mexico with Guillermo Foladori on the responsibilities of nanoscientists, is now working at NASA Headquarters after completing a Presidential Management Fellow at NASA.
  - Hays, who completed his doctoral degree in Politics and Global Affairs in Dec 09 on a topic in (original) TRC 1, served in Washington, DC with the New America Foundation as the lynchpin of its Future Tense collaboration with ASU and Slate.com. He is a post-doctoral fellow at the University of Bergen, Norway.
  - Valdivia (Public Affairs), who completed his doctoral degree in May 11 on a topic in TRC 1, “Equity Considerations in the Assessment of the Bayh-Dole Act,” is now a technology policy fellow at the Brookings Institution.
  - Anderson (Public Affairs), completed his master’s degree in May 10, has a chapter in the third volume of the Yearbook, co-authored a paper with Fisher related to RTTA 1 and RTTA 4 research, and completed his doctoral research at the University of Georgia working with Bozeman. Anderson is an assistant professor in the School of Public Affairs at ASU and an advisor to the president of the university.
  - Nulle (Global Technology and Development), who completed her master’s degree in May 10, has a chapter in the third volume of the Yearbook.

At Wisconsin, 20 doctoral students (Binder, Dudo, Ho, Dalrymple, Shih, Hu, Hillback, Akin, Cacciatore, Choi, Doroshenko, Kim, Li, Liang, Liu, Runge, Simis, Su, Spartz, and Yeo) in Life Sciences Communication and Communication Arts have been working with RTTA 2 data. Several of these students have received Center Support through graduate research assistantships. Six of this group have so far secured faculty positions, including:

- Ho, who graduated in 2008 with a PhD in Journalism and Mass Communication and is now a tenure-track assistant professor at Nanyang Technological University in Singapore;
- Binder, who graduated in 2010 with a PhD in Mass Communications and is now a tenure-track assistant professor at NC State University;
- Dudo, who graduated in 2011 and now holds a tenure-track position at the University of Texas at Austin;
- Dalrymple, who also finished in 2011 and is an assistant professor at the University of Iowa; and
- Cacciatore, who finished his dissertation in 2013, will be an assistant professor at the University of Georgia.
- Yeo (PhD, expected 2014) will begin tenure-track assistant professor position at the University of Utah during the Fall of 2014.
Other doctoral students trained at Wisconsin include: Leung, who completed his PhD in Sociology (2008) using CNS data and is now an assistant professor at SUNY Albany; and Jason Gallo, graduated with a PhD from Northwestern and is now employed at the Science and Technology Policy Institute, a privately-operated FFRDC, in Washington, DC. Noel Benedetti defended her M.S. degree using RTTA 2 data in 2010 and works as a technology consultant. Researchers and graduate students at Wisconsin also regularly participate in informal science outreach efforts, including Wednesday Nite at the Lab and the Wisconsin Literacy speaker series. Several students contributed entries to the *Encyclopedia of Nanoscience and Society*. Almost all peer-reviewed publications by RTTA 2 include graduate student authors, and many include graduate students as lead-authors. Faculty members and graduate students at Wisconsin have formed a research group – named “Science, Media and the Public” or “scimep” – that meets weekly to discuss research progress. This group includes members of not only RTTA 2, but members of the NSEC at Wisconsin. The meetings have helped foster collaborative work between the two NSF-funded grants (e.g., the recent publication by Runge and co-authors in the *Journal of Nanoparticle Research*).

In Su 10, RTTA 2 researchers also spearheaded the first online course in Science, Media & Society at UW-Madison, offered exclusively through iTunesU with select lectures being publicly available to all audiences. The Holtz Center for Science and Technology Studies at WU also just accepted a proposal from Scheufele to teach a course in “Science and Society,” which is jointly offered for students in Life Sciences Communication and Science and technology Studies. Scheufele continues to teach the course to more than 100 students annually.

At Georgia Tech, three doctoral students (Arora, Li), two visiting doctoral students (Yi Zhang and Xiao Zhou of Beijing Institute of Technology of the Chinese Academy of Science), one master’s student (Horsley), and two undergraduates (O’Brien, Skolky) worked with RTTA 1, with a focus on CNS-ASU themes, data and analyses, many toward their theses. RTTA 1 senior faculty and students meet on a regular basis (complete group meeting every Friday morning) for progress reviews, discussion of projects, publications, methods, and new ideas, mentoring, and (occasionally) hosting visiting speakers. All RTTA 1 doctoral students have participated in the initial meetings of the new Innovation Co-Laboratory (Georgia Tech, University of Manchester, and Beijing Institute of Technology), which has a focus on developing joint projects (in the nanotechnology and society domain) and doctoral training. Public Policy PhD student Yu Meng also worked with the RTTA 1 group.

Doctoral student Carley graduated in Sp13. Recent graduate Tang (Public Policy) is an assistant professorship position in public administration and policy at the Shanghai University of Finance and Economics, and Kay (Public Policy) has a post-doctoral fellowship with CNS-UCSB. Tang and Meng completed research on a Robert W. Gore award ($10,000) from the Chemical Heritage Foundation to undertake case studies of nanomaterials innovation in China. Based on RTTA 1 research, Arora, Carley, Kay, Tang, Meng, and Horsley authored or co-authored one or more journal submissions, journal papers or book chapters this year. Benn (a recent CNS-ASU PhD+ at ASU) was also a co-author with members of the Georgia Tech group.

TRC 1 at Georgia Tech supports four graduate students. Graduate students Rodrigo Cortes and Ogundiran Soumonni both finished their dissertations last year. Cortes is co-directing a Masters Program in Technology Management from his position at the *Universidad de Chile* and Soumonni is at the University of Witwatersrand in Johannesburg, South Africa.
Graduate student Thomas Woodson is finishing up his dissertation and has accepted an assistant professorship at Department of Technology and Society at SUNY Stony Brook.

The Center supported graduate students at other institutions in the organization, conduct and analysis of the National Citizens’ Technology Forum, including: Amy Barr (Sociology, University of New Hampshire), now a Visiting Assistant Professor at St. Lawrence University, Christina Ndoh (Public Administration, North Carolina State University), John Willingham (Political Science, North Carolina State University), Mark Philbrick (Environmental Science, Policy, and Management, University of California, Berkeley), and Javiera Barandiaran (Environmental Science, Policy, and Management, University of California, Berkeley). Philbrick and Barandiaran (2009) have published on their activities and have contributed multiple entries to the Encyclopedia of Nanoscience and Society. Philbrick is currently an AAAS fellow with the Department of Energy.

The associated STIR project, through a variety of workshops, group meetings, regular correspondence and one-on-one sessions, as well as site visits by PI Fisher, has trained and mentored the following twenty two (22) doctoral students (12 of whom have received their degrees so far) and two master’s students (who have received their degrees): Carlo Altamirano, ASU; Miles Brundage, ASU; Antonio Calleja-Lopez, University of Seville; Shannon Conley, ASU; Paul Ellwood, University of Leeds; Steven Filpse, Delft Technical University; Cecile Glerup, Copenhagen Business School; Birgitte Hansen, Copenhagen Business School; Cameron Keys, ASU; Byoungyoon Kim, Rensselaer Polytechnic Institute; Miao Liao, Tsinghua University; Federica Lucivero, University of Twente; Christine Luk, ASU; Bastien Miorin, Grenoble; Robin Phelps, University of Colorado; Daan Schuurbeirs, Delft Technical University; Anthony Stavrianakis, UC Berkeley; Frank Theys, Katholieke Universiteit Leuven; Francois Thoreau, University of Liege; Brenda Trinidad, ASU; Michiel Van Oudheusden, University of Antwerp; Qin Zhu, Dalian University of Technology. In addition, STIR has also involved the participation of four post-docs (one of whom has since joined the private sector): Dorothy Dankel, Ana Delgado, Hannot Rodriguez, and (former participating PhD student) Daan Schuurbeirs. In connection with their STIR-related work, Fisher also served/serves on graduate committees of Altamirano, Brundage, Calleja-Lopez, Conley, Keys, Phelps, Theys, Van Oudheusden and has provided formal feedback to the graduate advisors of Glerup, Kim, Liao, Lucivero, and Miorin.

At ASU, the second graduate student audience has been NSE researchers themselves. For these students, CNS-ASU created the CNS-Biodesign Fellows program, in which CNS pays one-third of their support. These students then participate in CNS-related curricular and co-curricular activities and perform what we call the PhD+, adding societal implications material to their doctoral research. The Center has graduated four PhD+ students: Troy Benn (Environmental Engineering; Westerhoff lab); Jason Lappe (Chemistry and Biochemistry; Woodbury lab); Quinn Spadola (Physics; Lindsay lab) and Tomasz Kalinowski (Biodesign; Halden lab). Spadola is now a AAAS fellow.

In its renewal period, CNS-ASU expanded the Fellows program to attract students from ASU’s Ira A. Fulton Schools of Engineering. The Center’s CNS-FSE Fellow, Ben Wender (Civil and Environmental Engineering, Seager Lab) started in Fall 11. In addition to integrating anticipatory approaches into his life cycle assessment, Wender has also been an active collaborator between CNS-ASU and the new QESST ERC, leading multiple publications on “anticipatory Life Cycle Assessment.” Wender along with Foley developed and delivered a session at the 2013 Winter School on interdisciplinary collaboration.
The success of the PhD+ has generated a great deal of interest beyond CNS-ASU. CNS researchers Guston, Miller, Bennett, and Wetmore, have been invited to participate on a number of technical grant proposals over the past year and support for future PhD+ students was written into several of these proposals. In addition, the CNS researchers at Georgia Tech have begun to implement their own program. CNS-ASU has turned the existing PhD+ program into a certificate open to graduate students in engineering and the natural sciences in “Responsible Research and Innovation in Science, Engineering and Society.” The Certificate, begun in Fall 13, graduates its first student, Caitlin Troyer, with a master of science in biology and society. Troyer is admitted to Harvard Law School for Fall 2014.

A number of the education activities originally developed by CNS to help graduate student scientist and engineers understand the social and ethical implications of their work were rolled into the Ethics in Engineering and Science Education (EESE) grant, on which Wetmore has been a co-PI. In one activity, Bennett participated in the Biological Design Graduate Program’s core course, “Fundamentals of Biological Design II.” Bennett attended every class and uses the presenter’s remarks as entry points into discussions of social, ethical or political aspects of research with the class and presenter. The response by the presenters has ranged from hesitant to fully embracing the conversation. From these interactions, several potential collaborations with presenting faculty have developed. The interactions with the students in the course resulted in recruiting Kalinowski as a CNS-Biodesign Fellow.

A second CNS/EESE collaboration involves laboratory engagement. During Fall 09 and Spring 10, Wetmore and McGregor worked with Steven Helms-Tillery’s neuroscience lab. They worked with the lab participants to reflect on the social and ethical implications of their research including the potential military uses and issues surrounding primate research. During Fall 10 Wetmore and McGregor worked with Patrick Phelan’s solar engineering lab where they discussed how different social and political changes would promote and inhibit the spread of solar power. In Fall 09 Wetmore was asked to consult on the development of a similar program at the University of Rothenburg in Germany. In Summer 10 he presented the model at the Annual Symposium of the International Research Training Group, ran the first laboratory session, and served as consultant to the program through its successful completion. This success of this activity has led to continued working relationships with PIs and students and it has been written into a handful of grants.

A third CNS/EESE collaboration is the series of one-credit courses entitled “Science Policy for Scientists and Engineers” that has been taught by Bennett, Posner or Wetmore nearly every semester for the past six years. It is a 1-credit seminar for NSE graduate students to explore questions and issues of science and technology policy in society that are relevant to their own research. Again this year the course was filled to capacity. The interactions with the students in the course yielded the first CNS-PSE Fellow, Moran, and it has drawn a number of other students into the Informal Science Communication Project. Because Posner left ASU and because of ever-increasing demands on their time, Bennett and Wetmore developed a new model for this year’s course. In 11 and 12, a biochemistry graduate student, Kiera Reifschneider was so interested in ensuring that the course was taught that she served as a co-instructor, helping to determine the year’s theme and facilitating much of the logistics required to keep the class running. Reifschneider successfully defended her dissertation in Oct 13 and has taken a Post-doc position with in CSPO funded by the NNIN.
The evaluation data generated under the EESE is impressive. Four models were evaluated – the embedded course (Bennett in Biodesign), a stand-alone course (Posner, Wetmore and Bennett 1-credit), laboratory engagement (Wetmore and McGregor in labs of Helms-Tillery and Phelan), and a hybrid course (Ellison and Herkert). Pre- and post- tests were given to all students involved. All four models were found to have a statistically significant and positive effect in helping students be more ethically sensitive, have more knowledge of relevant standards, and have better ethical judgment. These results are not typical for traditional responsible conduct of research courses and demonstrate the valuable contributions of these education approaches. The success of this EESE grant led to a second NSF EESE grant to develop macroethics modules for the online CITI program.

In Summer 13, CNS-ASU conducted three separate sessions of “Science Outside the Lab: A Policy Dis-Orientation” for graduate students, reflecting a rapidly growing interest among NSE students and faculty. Developed and taught by Wetmore and Bennett and held in Washington, DC, the course offers graduate NSE students a chance to leave the lab for two weeks to explore the relationships among science, policy and societal outcomes. Students meet government officials, lobbyists, staffers, regulators, journalists, academics, museum curators, and others who fund, regulate, shape, critique and study science, and they engage in hands-on policy learning through tours and exercises like a mock congressional hearing where students present their ideas for new policies to congressional staffers in the House Science Committee’s hearing room.

The previous success of the DC program has inspired a number of faculty to include funding for students to participate in it in their ERC, IGERT and education grant proposals. ASU currently has two Professional Science Masters programs – one in Science & Technology Policy and one in Solar Power Engineering and Commercialization – that require all of their students to participate in the DC program.

Bennett now leads the summer session programs, but brings in additional help to facilitate them. In Summer 12 CNS faculty Wetmore, CSPO Professor of Practice Gregg Zachary and former CNS post-doctoral fellow Delborne assisted with one session each. Each session is also facilitated by a student liaison who has participated in CNS immersion projects, taken multiple courses, and been mentored by Bennett and Wetmore. In Summer 13 there were two students who had gained the skills, knowledge, and enthusiasm about the social and political implications of nanotechnology to serve as a student leaders: Jen Fuller (PhD student, Environmental Social Science, ASU), Tracy Niday (Graduate, Chemistry and Biochemistry, ASU). The third session focused on sustainability policy and occurred for a week each in Washington DC and in London UK.

In Summer 14, CNS-ASU will once again conduct three sessions of Science Outside the Lab. Because of the success of the two PSM degree programs that require participation in the program, this year there will be one session dedicated to each of them. The first session will focus on solar energy policy. The second session will be tailored to the needs of the PSM in Science and Technology Policy and will include natural scientists and engineers. The third session will be occupied by science and engineering students. The programs were filled by the end of Mar 14 and prospective paying applicants have been turned away for lack of space.
In Fall 09, CNS researchers Wetmore, Bennett, and doctoral student Trinidad began to collaborate with Trevor Thornton and the ASU node of the National Nanotechnology Infrastructure Network (NNIN). The collaboration has resulted in two major programs: First, CNS-ASU now contributes the Social and Ethical Implications training required of all researchers who seek to use the ASU NNIN facilities. The training is part of the standard NNIN lab safety training that occurs at least once a month. Bennett, Wetmore, and doctoral student Trinidad have all served as instructors in the course (discussed further below).

Second, the ASU NNIN Node cosponsors with CNS-ASU the ASU Informal Science Communication Program for graduate students. The program offers training sessions every two weeks for students in how to communicate with the general public about science and engineering and then gives them the opportunity to gain important practical experience by presenting their work on the floor of the Arizona Science Center. The basic idea behind the program is to help young scientists develop valuable communication skills. The added bonuses are that the public gets to know about the cutting edge research being done at ASU and the students are asked difficult questions about the social and ethical implications of their work that they must develop good answers to. The program began in Mar 10 and students present at the museum monthly.

CNS scholars at Georgia Tech have also been helping to facilitate education in the social sciences for grants that are primarily technical in nature. Shapira, Youtie, and Porter have been collaborating with Elsa Reichmanis, Professor, Chemical and Biomolecular Engineering, Georgia Institute of Technology on a new IGERT Program entitled Nanostructured Materials for Energy Storage and Conversion and have participated in the Program’s inaugural seminar series by introducing students to “Trajectories of Global Nanotechnology Commercialization.”

In 2007, CNS-ASU developed a partnership with a new degree program the Professional Science Masters in Nanoscience, led by the Department of Physics and the Department of Chemistry and Biochemistry, to offer a 2-credit graduate course in the societal aspects of nanotechnology. Bennett has taught this course for the program since 2008.

In 2011, Wetmore collaborated with Patrick Phelan to develop and run a new Professional Science Masters in Solar Power Engineering and Commercialization. The curriculum of the PSM, sponsored in part by a $700K NSF PSM grant, has a significant focus on the ethical and political issues inherent in solar power. Wetmore has taught a 2-credit graduate level class on Solar Energy Policy with Mike Pasqualetti for the first two years after program was created. This class in the past has evaluated and offer suggestions to the Arizona Science Center’s “Solarville” exhibit. All students enrolled in the program will be participating in the DC summer session, which will continue to be a required component of the curriculum.

The third graduate student audience at CNS-ASU consists of those students in traditional departments and schools, as well as those in interdisciplinary programs, who are interested in CNS-related coursework. CNS-ASU faculty have established twelve graduate courses at ASU:

- In Spring 13, TRC 2 co-leader Wiek and Darren Petrucci, former director of the Design School, are offering “Design Thinking, Sustainability, and the Future of Nanotechnology in the City” in a cross-listed course between the School of Sustainability and the School of Design. The course brought together fourteen
graduate students to redesign the architecture and urban form of Phoenix to reflect four scenarios generated by TRC 2 researchers. The course takes a complex systems approach to design and draws upon societal context, innovation models, nanotechnology applications and urban sustainability problems to inform the urban design proposals in preparation by the studio. The resulting product from the studio – a short film – has been shown in many diverse venues, including Phoenix Biosciences High School and CSPO’s “New Tools” seminar in Washington, DC.

- In Spring 12, Selin developed and taught a research studio class through the School of Arts, Media and Engineering that explored the observation, documentation, analysis and summarization of large-scale collaborative events. Students in the class were trained either in ethnographic methods or observational media documentation and applied their skills in the field at the Emerge event (see Section 9 Research Program, Accomplishments, and Plans, RTTA 3). Subsequent to the event, and using the collected data, the students spent the remainder of the semester designing and developing a physical gallery exhibition, participating in the creation of a dynamic online media archive, and/or contributing to analysis of the Emerge event as a novel form of future-oriented deliberation.”

- In AY 11-12, Guston developed and taught with CSPO Professor of Practice Gregg Zachary the two-semester sequence, “Science and Technology Policy” and “Advanced Science and Technology Policy,” the core sequence for the STP PSM. The course achieved a novel synthesis of analytic and communication approaches and explored key tools like real-time technology assessment and anticipatory governance, as well as substantive topics like DIY biology and manufacturing, derived from the CNS agenda. Guston taught the sequence solo in AY 12-13 and AY13-14.

- In Spring 11, Fisher developed a new course entitled “Analysis of Scientific and Technological Innovation Systems,” primarily for graduate students in the PSM in Science and Technology Policy Program. A number of HSD students have taken the course as well. The course draws on a number of Fisher’s research projects within CNS.

- “Future Scenarios, Anticipatory Governance, and Sustainability – Urban Development in Phoenix” was offered by TRC 2 co-leader Wiek and RTTA 3 co-leader Selin in Sp 10. The course engaged 22 graduate students from five ASU graduate programs in systematically crafting visions of sustainability for Phoenix and developing governance strategies for transformative change. The course also integrated the theme of urban socio-technical systems and emerging technologies. As the course was embedded in a collaborative research project with the City of Phoenix to inform the adaptation of the General Plan, the course facilitated research in teams and involved faculty across ASU as well as stakeholder groups across the city. The course built capacity in anticipatory governance and attracted students to engage in subsequent research. Moreover, it created a network among stakeholders, professionals, and decision makers in Phoenix interested in “Nano and the City.” In Spring 11, ASU awarded the course its President’s Award for Sustainability. In Spring 12 Wiek reworked the course into “Sustainable Solutions: Options for Phoenix,” to continue to engage graduate students in TRC 2 research. Three walking audits that brought together researchers, Kay and Wiek, with graduate students and community members has strengthened the novel methodology of walking audits to co-train community and academic actors on the complex, place-based urban sustainability syndromes, while seeking solutions (including nanotechnology).
• **Wetmore** created a new course in Spring 10 entitled: “Introduction to Analyzing Sociotechnical Systems,” offered in the School of Human Evolution and Social Change. Not only were a number of nanotechnology topics covered, but students were also assigned a research project to develop a demonstration for NanoDays 2010. This class also fulfills a core requirement of the Professional Science Master’s Degree program in Science and Technology Policy offered by CSPO. Wetmore taught this course again in Fall 10 and Spring 12 and 13 and attracted a number of HSD students as well.

• In AY 09-10, **Boradkar** developed a training program akin to InnovationSpace but for graduate students. Two students under his direction have performed additional research, design and development on nanotechnologies previously conceived by the undergraduate InnovationSpace students.

• “Nanotechnology: Law and Regulation,” was taught by **Marchant** in the Sandra Day O’Connor School of Law in Spring 10. Several other CNS-ASU faculty participated in the course, including **Guston**, **Robert**, and **Selin**. As a major project the students explored potential regulatory and liability issues in the scenes developed by NanoFutures.

• “Governing Emerging Technologies,” taught in Fall 08 and Fall 09 through the School of Politics and Global Studies by **Guston** and in Fall 10 and Spring 12 by **Fisher**, explores the Center’s core concept of anticipatory governance and synthesizes many of the Center’s findings. Students in the course were tightly integrated into the Center’s activities, e.g., participating in the Oct 08 Visioning Workshop and the Nov 09 Equity Workshop. Several other CNS-ASU faculty have participated in the course including **Gonz**, **Corley**, and **Selin**. This class also fulfills a core requirement of the Professional Science Master’s Degree program in Science and Technology Policy offered by CSPO.

• “Energy and Energy Policy,” taught by **Bennett** in Spring 09, is a 1-credit seminar for PhD students in chemistry that explores the dynamic interplay between scientific research, technological innovation, policy development, and cultural change surrounding large-scale energy system change in the 21st century.

• “Science, Technology and Developing Areas,” a one-credit course offered through the Department of Chemistry and Biochemistry and the School of Human Evolution and Social Change, was developed in F 09 by Harsh and Wetmore to work through TRC 1 topics with graduate students. The course attracted graduate students from the social sciences, natural sciences, and engineering and explored the myriad issues that must be addressed for technical assistance to truly benefit the disenfranchised.

• “Nanotechnology, the Brain, and the Future,” taught in the School of Life Sciences and the School of Politics and Global Studies, is a variable-credit course offered by **Miller** and **Robert** (Fall 07, Spring 08, Fall 08) as part of the E2E project. Students and faculty used it to prepare research projects for E2E and the CNS All-Hands meeting.

• “Science, Technology & Societal Outcomes,” taught in the School of Life Sciences and the School of Human Evolution and Social Change by **Wetmore** and **Bennett** was offered in Spring 06 and Spring 07.

The Center has also been an integral part of the development of a new doctoral program at ASU, the Human and Social Dimensions of Science and Technology (HSD), which was approved by the Arizona Board of Regents in Dec 07 and matriculated its first class in Aug
08. CNS Associate Director Miller directs the HSD PhD program, and Guston, Robert, Sarewitz, Corley, and Wetmore serve on its Executive Committee. Other CNS faculty, including Fisher and Selin serve as members of its Graduate Faculty. In addition to the summaries of HSD students who are working specifically with CNS-ASU provided above, numerous other HSD students have participated in CNS-related activities over the life of the Center, including the scenario-based solar-to-fuels workshop, the anticipatory governance visioning workshop, CNS-ASU All-Hands meetings, and Emerge.

While the vast majority of classroom-oriented activities at CNS-ASU have occurred at ASU, in Summer 10 co-PI and RTTA 2 co-leader Scheufele and his Wisconsin team created an online class, Science 2.0: Media, Politics, and Emerging Technologies, for both graduate and undergraduate students, offered over iTuneU. This course is the third that CNS-ASU affiliates have offered completely on-line, with Harsh’s undergraduate Science and Democracy in Winter 10 and Hays’ Human Enhancement and Democracy class in Summer 10.

Undergraduate Education and Training

CNS-ASU organizes a variety of undergraduate education and research training experiences. Although there are none in the current year, in previous years, numerous undergraduates have written honors theses with CNS faculty, and undergraduates – mostly from the W.P. Carey School of Business – also complete honors theses in conjunction with their InnovationSpace coursework.

Previous honors students are also publishing their thesis research in CNS publications:

- Arielle Silverman, whose undergraduate thesis in Biology and Society surveyed a population with visual impairments about their attitudes toward nano-enabled therapies and enhancements in conjunction with TRC 2, published her work in the third volume of the Yearbook;
- Tobie Milford, whose undergraduate thesis in Religious Studies reviewed public participation in science literatures and analyzed TRC 1’s Nanotechnology and Religion workshop, published his work in the third volume of the Yearbook and has written several entries for the Encyclopedia of Nanoscience and Society. Milford’s undergraduate thesis also helped to win the Kelly Maxwell Outstanding Graduate Student Award from the Intergroup Relations Center Awards Committee and the Religious Studies award for “Outstanding Concurrent Major.”

CNS has supported several undergraduate student interns since the last annual report: Sarah Hoke (TRC 2, Nano and the Future of the City database project), Daniel Escolin (videography support, including the videotaping and editing of all presentations and special projects), and Evan Taylor (TRC 2, Nano and the Future of the City/database development project). Tai Wallace worked on generating content for the TRC 2, Nano and the City/database development project. Wallace graduated in December, 2012 and has since been hired by the Arizona Department of Environmental Quality in the air quality division in special applications unit.

In addition to the numerous undergraduate courses developed in the first five years of CNS – including “Perspectives on Nanotechnology,” “Justice and the Future,” “Learning Community: Nanotechnology in Society,” “Human Enhancement and Democracy,” “Global Environmental Politics,” “Technology and Society,” and “Science and Democracy” – nanotechnology and society issues were newly integrated into two other undergraduate
courses. Harsh revised the “Science and Democracy” course for Winter 10 as a 3-credit online course with interactive and video-enhanced oral exam modules, and Hays will taught an online version of Human Enhancement and Democracy in Summer 12. In Spring 11, Miller, Bennett, Harsh, and Wetmore developed a new, 125-student undergraduate course entitled “Introduction to Science & Technology Policy,” which integrated discussions about nanotechnology into each of the course’s five focal topics: health, food, military, economy, and environment. The course has been offered each Spring by other CSPO faculty. In Spring 14 CNS Post-doc de Ridder-Vignone developed this course into an online course and taught it.

CNS-ASU’s long-standing relationship with InnovationSpace continued this year. InnovationSpace is a two-semester long, transdisciplinary course collaborative among the ASU Schools of Design, Engineering, and Business. It satisfies the design or project requirements for senior majors in each school by creating cross-functional teams who use an Integrated Innovation model to research, develop and refine real-world product concepts for paying sponsors. In AY 13-14 currently in progress, the students have been developing nano-enabled products and services to address issues of child safety and enabling autistic children. For the last two years, the student teams have been tightly aligned with the TRC 2 program (See Section 9 Research Program, Accomplishments and Plans RTTA 3/2).

During summer 2012, the Georgia Tech contingent of TRC 1 served as mentor to one of the NNIN’s two REU students focused on the societal and ethical implications of nanotechnology. Duy Do, an electrical engineering major at San Antonio College, spent the summer in Atlanta studying the websites of about 60 companies doing research on water, agri-food, and energy nanotechnology. He researched the ways in which these companies were using nanotechnology and whether their products would affect equity issues. He presented his work in a report – “Nanotechnology Companies in the U.S.A: A Web-Based Analysis of Companies and Poverty Alleviation” – at the NNIN’s August REU convocation in Atlanta.

Scheufele teaches a course in “Science, Media, and Society,” which has been offered jointly to undergraduates by the Department of Life Sciences Communication and Science and Technology Studies. This new curriculum offering was informed heavily by the last 8 years of CNS-related work at UW, and has become a required course for all Life Sciences Communication majors at UW, one of the fastest-growing majors in the College of Agricultural Sciences. The course currently enrolls students from five different colleges at UW.

K-12 Education

TRC 2 has been actively engaging with science educators and students at the Bioscience High School through various partnerships and exchanges. Bioscience High School is a public high school in Phoenix that is a magnet for college-bound students interested in science, technology, engineering and math (STEM) education opportunities. TRC 2 is building upon existing relationships held by co-leader Wieck and faculty at the school. In the previous reporting year, the Bioscience High School welcomed the entire student body of the CNS Winter School on Anticipatory Governance for an exchange between graduate students and high school students. This past academic year faculty from the Bioscience served as speakers at the monthly Science Café Series (see Outreach section). Additionally, post-doc
Foley and graduate student Rushforth offered presentations to the entire sophomore class on the M52 Superfund Site. Bioscience High School has committed to taking on the M52 Superfund Site as this year’s annual project for students to investigate the technical, scientific and social uncertainty that generate misunderstandings and perpetuate a lack of trust between regulatory agencies and citizens. That initial visit was followed by a presentation by Foley and the Maricopa County’s Sustainability Manager, Jonce Walker, on the impact of the built environment on urban sustainability challenges. The Phoenix metropolitan area is located almost entirely within Maricopa County making the co-presentation between neighborhood and metropolitan scales apparent and meaningful for students. This co-presentation strengthened the ties between TRC 2, Maricopa County and Bioscience High School.

In a previous reporting year, CNS-ASU described the development of a graduate course that provided in-service K-12 teachers with research experiences and also helps them develop curricular materials for their own K-12 classrooms on societal aspects of nanotechnologies. CNS did not offer a version of the course in the current reporting year. Two teachers participated in the course in Spring 09, one in-service and one who is in the nano-science professional master’s degree program and does not currently teach. The value of the course is demonstrated by continuing follow-ups by in-service teachers with Bennett, who has consulted with some of those in the course about the development of curricular materials and visited classrooms at Mesa High School and its Biotech Academy. In one of these classes the in-service high school teacher from Bennett’s Nanoscience in Society course had her students choose specific technologies and analyze the social, political, and cultural aspects of that technology and then promote a policy position through an oral presentation to their class and prepare a letter to a congressional representative. Bennett was also a principal in the Citizens Engagement Program with High School Students in conjunction with CSPO and ECAST (see Section 12 Outreach and Knowledge Transfer).

CNS-ASU has also arranged for its Science Cafés, held monthly during the academic year in conjunction with the Arizona Science Center (see below) to provide in-service teachers with continuing education credit. In addition, CNS co-director Miller served as a primary consultant to two chapters (4 and 13) in The Big Ideas of Nanoscale Science and Engineering (Stevens et al. 2009) published by NSTA Press for K-12 science teachers. These chapters are based, in part, on a guide to nanotechnology in society education produced by CNS (Miller et al. 2007). Much of the work done with NISE Net and the Arizona Science Center (see sections above and below) reaches K-12 audiences. It is also the case that one of the target audiences for the Encyclopedia for Nanoscience and Society (Guston 2010) is high school students and teachers.

Informal Science Education

CNS-ASU has begun to have a significant impact on informal science education nationally through its partnership with the Nanotechnology Informal Science Education Network (NISE Net) to incorporate research on the ethical and societal implications of nanotechnology into museum programs and exhibits around the country. Early in its operation, CNS produced a guide to this topic (Miller et al. 2007) that NISE Net distributes as part of its Forums Guide and NanoDays Kit. This guide has also been distributed widely to science museums at NISE Net meetings and is available on the CNS-ASU website for download. In addition, NISE Net Director Larry Bell, who has attended nearly all of the CNS All-Hands Meetings and serves on the CNS Board of Visitors, has identified anticipatory
governance as a central theme for future NISE Net programming and, more broadly, as the basis for a new model for the role of science museums in informal science education (Bell 2008). Most significantly are the series of workshops that occurred in conjunction with NISE Net to train museum staff in how to facilitate conversations about nanotechnology and society. Details of this strong collaboration can be found in Section 12 Outreach and Knowledge Transfer.

**Practitioner Training**

The Center has developed and piloted training modules in the ethical and societal implications of nanotechnology for scientists and engineers working in user facilities at the DOE Center for Integrated Nanotechnologies (CINT) and the National Nanotechnology Infrastructure Network (NNIN).

For the first few years, NNIN user facilities were strongly encouraged to use the video (created by Guston and others) and a survey was conducted to evaluate their experience. Respondents at 9 of the 11 user facility sites in the NNIN indicated that they were already using the video, and an additional site indicated that it would be doing so from this point forward. Four sites indicated that the video had been presented at a total of 117 training sessions, with the other sites indicating that users watched the video individually, with no formal records being kept. The sites indicated that approximately 1000 NSE researchers in total had watched the video. The actual use of the video varied. Some sites merely made the video URL link available. Other sites asked users to verify via a signature that they had viewed the video. Others required users to watch the video in groups. One group indicated that questions and comments sometimes follow, and one group indicated that they always follow the video with group discussion. Post-doc Reifsneider is currently attempting to follow up with the various NNIN sites to see explore the possibility of conducting an evaluation of this program.

While the video remains on the NNIN website for use at some sites, after much deliberation NNIN decided that face-to-face discussions of SEI issues would better engage the researchers at its user facilities. Wetmore attended a workshop in Jan 10 at Cornell University and Bennett attended a workshop in Oct 10 at Washington University in St. Louis to help inject CNS-ASU experience and knowledge into NNIN training across the country. Wetmore, Bennett and Trinidad have developed a thirty-minute module that is presented in conjunction with the health and safety training that all users of the ASU NNIN facility must successfully pass. The module introduces researchers to the practical implications and applications of CNS research and findings, while also making them aware of the support CNS can offer to young scholars in the form of PhD+ opportunities and coursework.

Wetmore and Sarewitz also participated as Faculty in the IHEST European Summer School: Which Place for Science in the Public Debate? at the Saline Royale d’Arc et Senans, France in Summer 10. This summer school was established in large part to help local and national French officials reflect on the protests during the government’s effort to solicit input into its nanotechnology decisionmaking process. The summer school resulted in a publication that included Wetmore and Sarewitz’s lectures in French.

**Winter School**
In the Winter 14 CNS-ASU hosted its second Anticipatory Governance of Emerging Technologies Winter School at the Saguaro Lake Ranch in Mesa Ariz. It was attended by 17 junior scholars (graduate students or PhDs fewer than three years out) and by faculty from the RTTAs and TRCs as well as the assistant and associate directors. The student participants represented 16 institutions from 8 countries. In the spirit of the Gordon Research Conference, intense topical sessions were interspersed with activities designed to build the group into a cohort and take advantage of the natural resources at the Ranch. The post-school evaluative session indicated that general format and topics were appropriate and facilitated a cohort model of learning that was deemed successful by participants. Based on feedback from this session and other comments CNS will conduct another Winter School in Jan 15. Highlights for the participants included their interactions with All-Hands and Board of Visitors attendees, as well as participants of the Futurescape City Tours research groups from Boston, Edmonton, Portland, Washington, DC, and Raleigh-Durham.
Table 3A: Education Program Participants, Irrespective of Citizenship

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### Table 3B: Education Program Participants, U.S. Citizens or Permanent Residents

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12. Outreach and Knowledge Transfer

The outreach activities at CNS-ASU are, on one hand, tightly integrated with research and education and, on the other, governed by a strategy that aims at developing broad-based capacities among both NSE researchers and various publics. As described in the strategic research plan, CNS-ASU pursues an agenda of foresight, engagement and integration in order to advance its strategic goal of building capacities for reflexivity and anticipatory governance in the NSE enterprise in particular and in society more broadly. CNS-ASU thus has a dual-tracked outreach strategy that includes, in one track, outreach to various lay-publics (engagement) and, in the other track, outreach to scientists and engineers (integration). In addition, CNS has more traditional outreach and knowledge transfer to professional colleagues via workshops and presentations, as well as a modest technology transfer program associated with InnovationSpace. In YR 9, we have deepened our collaboration with museum professionals and published an important guide to practice. A highlight of YR 9 was publishing the inaugural issue of the Journal of Responsible Innovation.

Collaborations with the Nanoscale Informal Science Education Network (NISE Net)

“Nanotechnology is relevant to everyone’s lives, and has important societal and ethical implications” is one of the original learning goals established by the Nanoscale Informal Science Education Network (NISE Net). This goal was somewhat of a departure from traditional science museum content; soon after its creation, NISE Net recognized that CNS-ASU could be a valuable partner in developing programs in this area. For the past several years, CNS-ASU has developed demonstrations, presentations, posters, and film scripts for NISE Net to help introduce nano-and-society ideas to museum guests and have helped build up significant trust and good working relationship. Over the last 2 years this relationship has strengthened considerably. In Summer 2012, CNS-ASU officially became a “core partner” of NISE Net, a position formerly reserved for major subcontractors. Bennett, Miller, and Wetmore continue to serve on the NISE Net content committee and Miller serves on the advisory committee (and NISE Net PI Bell serves on the CNS-ASU Board of Visitors). The relationship is now truly an integrated partnership. Both groups are engaged in projects that simply would not be possible without the collaboration.

Nano and Society ‘Train the Trainer’ Workshops

After several years of collaboration, CNS and its NISE Net colleagues realized that a major stumbling block to our collective effort was that people working on the floor of museums were simply not comfortable straying from their role of serving as experts in science facts. In last year’s report, we detailed the extensive activities undertaken to address this problem, including: 1) the production of a series of seven short videos about nanotechnology and society that could be used in museum training sessions or as basic technology and society teaching tools (available at http://nisenet.org/catalog/tools_guides/nano_society_training_materials) (NISE Net reports 877 unique page views); 2) a series of four regional workshops that reached more than 100 museum professionals from more than 50 science museums and centers (503 unique page views); 3) a series of subsequent engagements including online forums, conference calls, and a follow up workshop at the NISE Net annual meeting in Dec 12 in Boston; the inclusion of materials in the 2013 NanoDays kits; and the further professional dissemination of this material at 4S and S.NET meetings and meetings with museum professionals at the Science Museum, London, and at the University of Edinburgh.

The workshops were groundbreaking as the first nation-wide training program initiated by NISE Net and one of the first nation-wide museum training programs ever in the US. This success
convinced NISE Net to develop additional training programs every year. The training programs helped to spark a shift in how science centers relate to their visitors. Many participants have wanted to engage the public in discussions about values and futures, but had not yet made it a normal part of their interactions. Many have remarked that the workshops gave them the courage, tools, and support to begin to make a concerted push for on the floor conversations. The first paper from this project has been published as Ostman et al. (2013).

In the current reporting year, the CNS/NISE net team has followed the workshops up with the publication of a booklet, “Nanotechnology and Society: A Practical Guide for Engaging Museum Visitors in Conversations.” This guide encapsulates many of the lessons of the workshops into an easily accessible booklet. The guide serves as an introduction for museum professionals new to the topic and a refresher for those who participated in the workshops. The guide was included in the 250 2014 Nanodays kits that were distributed this spring, and it is currently available for free download at: http://www.nisenet.org/catalog/tools_guides/nanotechnology_society_guide (96 unique page views). In addition, Wetmore and Bennett offered a NISE Net webinar in Mar 14 (archived at: http://nisenet.org/community/events/online_workshop/online_brown-bag_nano_society_recorded) and will follow up in May 14 with a second webinar to the Association of Science and Technology Centers, both focused on delivering the training information to a broader set of museum professionals.

Mini Nano Exhibit

Bennett and Wetmore served as consultants on one of the most ambitious projects that NISE Net has performed – the Mini Nano Exhibit project. CNS scholars provided valuable feedback and helped to evaluate the 200 square foot exhibit that NISE Net developed to focus on nanotechnology in everyday life. The original plan to produce 50 copies of the exhibit increased to 70, and they were distributed to museums across the country. Because of the collaborations NISE Net designated one of the first five exhibits produced to be sent to the Arizona Science Center to give CNS-ASU scholars easy access to the display as we develop further activities around it, e.g., a discussion space for the Winter School. NISE Net estimates that Mini Nano reaches more than 7 million visitors each year.

Nanoequity Card Game: “Nano Around the World”

NISE Net has also been instrumental in developing the nanoequity card game, “Nano Around the World.” Some of the NISE Net leadership were present the first time the game was introduced at the 2011 S.NET annual meeting and asked TRC 1 if we would be willing to jointly develop the game. Since Nov 11 Wetmore has collaborated with NISE Net to refine the text, develop new graphics, and review the content for consistency and accuracy.

The game has served two important interrelated purposes. First it has been very effective in getting members of the public to understand current and potential applications of nanotechnology, consider the equity issues inherent in the current system, and reflect on what their own goals for nanotechnology might be. It has been used by CNS members to teach high school students, undergraduate courses, and museum audiences. Museum professionals have used it in science summer camps as well. Wetmore alone has administered the game about 20 times. Second, the game has been very useful as a training tool. It was when NISE Net administrators played the game in January 2012 that they became convinced that workshops in nano and society would be possible. Since then we have used the game to introduce the topic at the beginning of every Nano and Society workshop, and we used it to break the ice at the 2013 and 2014 Winter Schools and teach participants about public engagement.
While “Nano around the World” has been embraced by many museums and is being used frequently, it did not quite fit the normal museum demonstration format because it works best with players who are in their teens or older and the game takes 20-30 minutes to play. Consequently, Wetmore and a number of S.NET colleagues have developed a simpler version of the game called “You Decide” that can be played with children as young as 5 and in a timeframe as short as 3 minutes.

Hard copies of both games were distributed to the 50 institutions that took part in the Nano and Society Workshops. Digital versions are currently available for free download at nisenet.com (“You Decide” has 866 unique page visits). A hard copy of the “You Decide” game was included in both the 2013 and 2014 Nanodays kit that was sent to 250 sites across the country. The game has been played all over the world. It is reasonably uncommon now to run a game with a group of people who have never played it before as science centers and public outreach groups from research programs like the NNIN facilitate the game frequently.

*Three Angry Scientists*

In Jan 12, playwright Melanie Wehrmacher completed the script of a ten-minute play, “Three Angry Scientists,” commissioned by the Science Museum of Minnesota (SMM) and based on an idea from Guston derived from his scholarship on the role of science in regulatory decision-making. SMM hosted performances of the play in Spring 12, and Wehrmacher has now completed a new version of the play that introduces nanotechnology, in the form of a nano-enabled drug, into the decision-making of the scientists who are debating whether or not to approve the drug as safe and effective for human use. A film of the play is now available for free download from the NISE Net website: [http://www.nisenet.org/catalog/media/three_angry_scientists](http://www.nisenet.org/catalog/media/three_angry_scientists). As of Jan 14, there were 1322 loads of the film on Vimeo and 250 plays on YouTube. NISE Net also included the film on DVD in its 2014 NanoDays kit, distributed to 250 museums and science centers.

*Collaborations with the Arizona Science Center*

Over the past two years, the already strong collaborations CNS-ASU has had with the Arizona Science Center have strengthened considerably. The Informal Science Education Program that CNS coordinates with the ASU node of the NNIN sends a group of graduate students to present on the museum floor at least once a month throughout the academic year, including the annual Nanodays event. CNS’s oldest outreach activity – the Science Café – has been held monthly during the academic year at the Science Center since 2007. Projects like these have built up a great deal of trust between CNS scholars and the Arizona Science Center administrators. They now see CNS as one of the first organizations they go to in order to develop joint projects.

The Science Center has also opened its doors as a place for CNS scholars to develop and test new projects and to work collaboratively on sponsored research. In the current year, Bennett is part of the ASC team that carries out an NIH Pathways grant. The Science Center is also helping CNS researchers Wetmore and Bennett to develop a small museum exhibit in conjunction with the Life Cycle Nanotechnology grant the EPA recently awarded ASU. CNS also provides an expert resource to the Science Center.

*Science Cafés*
The CNS-ASU Science Café series continued this year. It is hosted on the third Friday of every month during the academic year by the Arizona Science Center in downtown Phoenix. The theme for the YR 9 series was citizen science. Speakers and topics this reporting year included: “Bridging the Gap: Meeting Challenges, Building Capacity” by Stacie Beute of the Desert Botanical Garden, “New Technologies, New Audiences” by Darlene Cavalier, SciStarter Founder and Senior Advisor to Discover Magazine, and “ Citizen Science Goes to Mars!” by Sheri Klug Boonstra, Director of the Mars Education Program at ASU’s Mars Space Flight Facility. Attendance has been flagging, however, and we are re-evaluating both the location and the style of presentation.

**NanoDays 2014**

As in previous years, CNS-ASU is participating in NanoDays by adding the societal “so what?” twist on the information and materials provided by NISE Net. In coordination with the NanoDays national program, CNS-ASU sponsored three days of demonstrations about phenomena at the nanoscale. Two-dozen students from graduate classes taught by Bennett and CSpO visiting assistant professor Jennifer Richter as well as students newly active in the Informal Science Communication Program participated in public displays at the Tempe Festival of the Arts, a street art fair that attracted upwards of 250,000.

**Other Museum Collaborations**

**Partnership for Education on Climate Change, Engineered Systems, and Society (CCEP)**

In YR 6, Miller (then co-PI) received a CCEP award (NSF #1043289) to establish a coordinated national network of regionally- or thematically-based partnerships devoted to increasing the adoption of effective, high quality educational programs and resources related to the science of climate change and its impacts. This award to the US National Academy of Engineering (Rachelle Hollander, PI) established a Phase I CCEP in collaboration with ASU, the Museum of Science-Boston, the University of Virginia, the Colorado School of Mines, and the Phoenix Union High School District. It focused on the impacts of climate change for engineered systems, and its goal was to catalyze and transform engineering education in science museums, cities, and undergraduate programs to prepare current and future engineers, policymakers, and the public to meet these challenges. At the end of January 2013, the Partnership hosted a conference on the impact climate change will have on America’s infrastructure. It brought together 75 scholars and professionals from a variety of backgrounds for two and a half days to discuss climate change science, engineering solutions, policy and governance challenges and strategies, sea level rise and storm surge, local government solutions, Native American perspectives, and engaging the public. The project ended in Aug 13 having unsuccessfully applied for a Phase II award.

**Frankenstein Bicentennial Project**

Guston and ASU colleague assistant professor Ed Finn, who directs the ASU’s Center for Science and the Imagination, have launched the Frankenstein Bicentennial Project, to recognize and celebrate the theme of creativity and responsibility in Mary Shelley’s gothic novel, *Frankenstein, or The Modern Prometheus*, first published in 1818. Together with co-PI Helms-Tillery, Finn (PI) and Guston (co-PI) received a small award from NSF to host an interdisciplinary, cross-sectoral workshop to explore new ways of collaborating and set new project agendas around the project themes. The workshop will take place 28-30 April 2014. Guston and Finn will seek to integrate the project with the CNS-supported *Emerge* event in 2017 or 2018 and carry on through it many of the relationships with scientists and engineers as well as with the museum community and various
publics that CNS has pioneered. While no CNS funds have been expended on it, this project develops and extends CNS attention to anticipatory governance and responsible innovation. In addition to the $50K NSF workshop award, the project has expended or had pledged or committed approximately $450K from various ASU sources.

**Broader Engagement Programs and Activities**

**New Tools for Science Policy**

CNS-ASU is leveraging the CSPO DC office to reach out to policy audiences. In YR 9 several CNS researchers presented at CSPO’s New Tools for Science Policy series, which asks: How do we know what science is "the right science" to do? How can we effectively orient the vast research enterprise to make real progress toward societal goals? Since its inception, CSPO and its network of researchers have been developing models, tools, and methods to help address fundamental questions in science policy. CNS researchers met DC policy audiences to catalyze discussions and collaborations between science policy researchers and decision makers about new ideas and approaches for improving the social value of science and technology. YR 9 CNS researchers included: Bennett and Herring of the Museum of Life and Science on “Transforming and Repositioning the American Science Museum: New Tools for Engaging the Public” in May 13; and Foley and Petrucci on "Design Thinking, Sustainability, and the Future City" in Feb 14. Selin and de Ridder-Vignone are scheduled to present on “Deliberating Differently: The Futurescape City Tours” in Jun 14.

**Informal Science Communication Program**

During YR 9, CNS-ASU and ASU’s node of the National Nanotechnology Infrastructure Network (NNIN) continued a program in informal science communication in cooperation with the Arizona Science Center. Graduate students interested in working with the public to promote a broader understanding of science and technology receive training in methods and techniques to engage with diverse audiences. These “Science Liaisons” then have the opportunity to work on the floor of the Arizona Science Center once or twice a month during the semester. Students of all disciplines are invited to apply. Faculty leads Thornton, Wetmore, Bennett, and student leader Trinidad provide ongoing support and mentorship through informal monthly group meetings and an online organizational space in the university’s courseware system, Blackboard. A set of informal and formal science educational resources, training materials, and a collaboratively-edited Google calendar schedule are accessible through the community site. Thirty-five students are now members of the online group and receive regular announcements about program activities; ten students have completed the training and are active volunteers. On average, during each visit to the Science Center the students engage with 60-70 museum guests. The program has significantly strengthened the relationship between CNS-ASU and the Arizona Science Center. This reporting year, Trinidad has begun to package the training regimen that all student volunteers receive into an exportable format. Wetmore will be using this program in Apr 14 to train graduate engineering students at the University of Western Cape to give Nanodays tabletop demonstrations at the Cape Town Science Center.

**ECAST**

In Apr 10, the Woodrow Wilson International Center for Scholars (WWIC) released the report *Reinventing Technology Assessment: A 21st Century Model* by Richard Sclove, founder and senior member of the Loka Institute, a non-profit research and advocacy organization concerned with the
social, political, and environmental repercussions of research, science and technology. The report gives an overview of participatory technology assessment, reviews its applications in Europe and some prototypes in the US, and it forwards a proposal to create the ECAST network – Experts and Citizen Assessment of Science and Technology (www.ecastnetwork.org) – a consortium of NGOs, non-profits and universities that administer public engagement events on scientific and technological topics relevant to policy makers. Guston and a network of partners at WWIC, Loka, Museum of Science Boston, Pomona College, CSPO and others discuss projects, funding mechanisms and network governance in regular conference calls. Since the report, ECAST partners have conducted several small-scale demonstration citizen engagement projects at several home institutions about emerging technologies including geoengineering, nanotechnology, and synthetic biology. ECAST has been instrumental in coordinating the participation of US sites in the Danish Board on Technology’s World Wide Views (WWV) on Global Warming (which overlapped substantially with NCTF sites) and the WWV on Biodiversity held in September 2012.

In the current reporting year, ECAST, via ASU, has been awarded a $200K cooperative agreement from the US National Aeronautics and Space Administration to perform a prospective, participatory technology assessment of the proposed Asteroid Initiative in which NASA would plan on capturing a small asteroid for purposes potentially including planetary defense, commercial development, and preparation and planning for other human deep space missions including Mars. The award contains funds for face-to-face deliberation projects at ASU and in Boston, coordinated by the Museum of Science, and virtual deliberations, coordinated by SciStarter.

Presentations to Public Audiences
Beyond those mentioned above, highlights in YR 9 include:
- Wetmore, “Nano Around the World,” Adult Night, Arizona Science Center, 3 May, 2013;
- Miller, “Futurescape City Tours: Public Engagement in the City,” President’s Umbrella Tours, Portland State University, 26 February 2014; and

Presentations to Policy and Professional Audiences
Beyond those mentioned above, highlights in YR 9 include:
- Scheufele, “Science Communication as Political Communication,” Sackler Colloquium on the Science of Science Communication, II, National Academy of Sciences, 23 September 2013;
- Corley, “Creating Collaborations for Communication about Nanotechnology Regulation,” Sackler Colloquium on the Science of Science Communication, II, National Academy of Sciences, 23 September 2013; and

Integration Programs and Activities

Integration with technical colleagues in the sciences and engineering continues to be a key component of CNS-ASU’s work – stretching from research to education, engagement, and outreach. It continues to be a key aspect.
National Nanotechnology Infrastructure Network

In addition to the Informal Science Education Training program for graduate students mentioned previously, the CNS-ASU continues broader discussions about integrating SEI issues in the NNIN. In Nov 11, Bennett attended the annual NNIN SEI Coordinators meeting at George Washington University where he presented such CNS-ASU programs such as the DC summer session and the 1-credit course for scientists and engineers. Wetmore and Bennett have developed with Thornton, leader of the ASU NNIN node, a twenty-minute module on SEI issues that is currently presented monthly in conjunction with the health and safety training that all users of the ASU NNIN facility must successfully pass. We use this orientation as a means to introduce researchers to the practical implications and applications of CNS research and findings, while also making them aware of the support CNS can offer to young scholars in the form of PhD+ opportunities and coursework.

Because of this engagement and the leadership that went into the Congress on Teaching the Social and Ethical Implications of Research that was co-sponsored by CNS and the NNIN in 2011, Wetmore was asked by the NNIN – now centered at Stanford – to serve as its SEI network coordinator. He took over this position in July 2013 and over the past year has worked on winding down the various activities as the grant is due to conclude in the very near future. The NNIN funding has provided the finances necessary to hire postdoc Kiera Reisfischneider, a recently minted ASU Chemistry PhD. Reisfischneider has assisted with a number of CNS projects including an evaluation of the Science Outside the Lab program.

In Aug 13 Wetmore, Bennett, and Reisfischneider also ran an ethics engagement exercise with the 100+ NNIN REU students at their annual convocation at Georgia Tech. Student feedback on the exercise was extremely positive. One student who applied to the NNIN REU program this year said that the one hour ethics program caused her to completely rethink her career trajectory and compelled her to focus on doing work with an eye towards developing countries.

The Stanford-led NG-NNIN was one of two finalists in NSF’s recompete of the NNIN, and the SEI component was favorably received by the reviewers. After delays caused by the government shutdown in Fall 2013, in Spring 2014 NSF announced it would not fund either of the NNIN proposals. Wetmore continues as SEI director of the NNIN as the grant sunsets over the next year. There has been some mention by NSF of bridge funds and a new competition, but it is not clear if bridge funds will include the SEI component. The research team is currently reworking the idea of building an SEI network on top of a technical research network to adapt it for the LCNano program.

Research Integration Presentations
Beyond those mentioned above, highlights in YR 9 include:

- Wetmore and Bennett, ”Education and Training Panel,” Sixth International Meeting on Synthetic Biology (SB 6.0), Imperial College, London, 10 July 2013;
- Foley, “Integrating Nanotechnology into Comprehensive Interventions to Global Challenges,” Gordon Research Conference on Environmental Nanotechnology, June 2013;
- Harsh, “Designing a Community Engagement Short Course for Engineers,” Global Engineering Symposium, Engineers without Borders Canada National Conference, January 2014; and
Collaborations with Academic Colleagues

Society for the Study of Nanoscience and Emerging Technologies (S.NET)

After CNS-ASU served as co-organizer and host of S.NET’s third annual meeting in Nov 11, S.NET continues to thrive in a way now largely independent from the original investments made by NSF. While many CNS-ASU faculty and students participated in this fifth annual meeting, and while both CNS’s were recognized in the program as “sponsors,” the program committee had only one CNS (UCSB) member and the newly elected leadership of the society is fully independent of the CNS’s. Specifically, CNS-ASU participation included: CNS-ASU board of visitors member Andrew Maynard provided a plenary address; Youtie collaborated with former CNS-ASU and now CNS-UCSB post-doc Kay and UCSB faculty Applebaum in a presentation on nano corporate strategies in Latin America; former CNS-ASU communication coordinator and current ASU doctoral student Gano organized a panel on “Data, Definitions and Epistemic Questions” that included a presentation by post-doc Reinsborough; Gano also organized a roundtable on data sharing issues for the field; Youtie, Shapira and colleagues presented a paper on bibliometrics of the next generation of complex nanomaterials; Guston chaired a panel on the nano-enhanced city that featured TRC 2 collaborators Foley, de Ridder-Vignone and Petruci; Guston also served as moderator and discussant for a screening of Regan Brashear’s documentary, Fixed, as a panelists for a discussion on responsible innovation, and as an official mentor to four early career researchers; and CNS-FSE fellow Wender presented on anticipatory life cycle analysis.

Governing Emerging Technologies: Law, Ethics and Policy (GET)

CNS-ASU provided significant support to the first “Governing Emerging Technologies: Law, Ethics and Policy meeting, organized by Marchant at ASU’s Sandra Day O’Connor School of Law. Guston served on the program committee and organized and chaired a plenary panel on responsible innovation. CNS-ASU speakers included co-PI Scheufele, senior investigator Woodbury, TRC 2 post-doc Foley, RTTA 2 graduate student Kim, senior investigator Poste, and senior investigator Marchant. CNS-ASU is providing similar support to the second annual meeting to be held in May 14.

Presentations to academic and professional audiences
Beyond those mentioned above, highlights in YR 9 include:

- Selin, “Prototyping Nanotechnology: Experiences with Design Education,” Technology and Innovation Management Research Seminar, Danish Technological University, Copenhagen, 25 October 2013; and
- Wetmore and Bennett, “Social and Ethical Implications of Nanotechnology,” NNIN REU Convocation, Atlanta, 14 August 2013.

Collaborations/Interactions with Industry and Other Sectors
Governance Scenarios for Cities (Phoenix)

Throughout the past four years, TRC 2 has repeatedly conducted engagement activities with expert and stakeholder groups, including industry. In this reporting year, the focus of engagement centered on sharing the “Nano and the City: Future Scenarios of Nanotechnology Innovation.” The scenarios were constructed with participation from representatives from the Arizona Corporation Commission (ACC), Arizona Nanotechnology Cluster (ANC), Arizona Biotechnology Association (ABA), Arizona Technology Council (AzTC), Arizona Technology Investors Forum (ATIF), Maricopa Association of Governments (MAG), various city officials, Greater Phoenix Economic Council (GPEC), Intel, SDC Materials, Phoenix Revitalization Corporation, and Bioscience High School. We visualized the scenarios in collaboration with the ASU School of Design through the production of a 15-minute film. The film is being shared via both online and in-person presentations. One recent presentation re-engaged with the ANC, ABA, AzTC, ATIF, MAG, GPEC and local industry at a monthly meeting of the ANC, and we will also be sharing the film with the Arizona Chapter of the United States Green Building Council.

CNS Private Sector Engagement

CNS-ASU postdoc Sarah Davies led the CNS private sector engagement initiative from October 2010 to September 2012 thanks to a supplemental NSF grant. While here in Arizona she developed an internal database and convened a workshop on “Nanotechnology, Business and Anticipatory Governance” in YR 7. In October 2012 she assumed a new position in the Department of Media, Cognition and Communication at the University of Copenhagen. The most recent product of her work is a special issue of Nanotechnology Law & Business vol. 9, iss. 3, that she co-edited with Noela Invernizzi. The issue examines private sector nanotechnology in developing countries, the influence of regulation on markets, and the ways in which corporations inform the public about their work.

InnovationSpace

CNS-ASU has a modest technology transfer program through its support of InnovationSpace (ISpace). One important output of ISpace is an invention disclosure by each of the cross-functional undergraduate teams. ISpace teams working with CNS have disclosed 12 inventions to ASU’s technology transfer arm, Arizona Technology Enterprises (AZTE) and at the end of the year will submit 3 additional invention disclosures. These disclosures have generally been the endpoint of technology development from ISpace, as neither it nor CNS-ASU has had the resources to perform follow-up research and development – although ISpace faculty leader Boradkar and Guston are attempting to cultivate potential sources of support.

Journal of Responsible Innovation

In Aug 13, Guston signed a contract with Taylor & Francis to publish the Journal of Responsible Innovation (JRI) under their Routledge imprint – the world’s largest publisher of social science journals. The effort had started several years earlier, when Fisher and several European colleagues began to draft a proposal. They eventually brought Guston on board, and together they revised the proposal and offered it to several presses (MIT, Sage, Oxford) and finally found a partner in T&F. JRI has an internationally esteemed set of associate editors and members of its editorial board. Volume 1, issue 1 appeared online and in print in Feb 14 (http://www.tandfonline.com/toc/tjri20/current#.U0ID915tiCU). JRI’s first issue will remain open access in perpetuity, and select and timely articles in future issues will be open access as well. The journal will also abide by the open access policy of the United Kingdom. In addition to an opening
editorial authored by Guston, Fisher and the other associate editors, CNS senior investigator and associate director for anticipation Selin has a piece in the inaugural issue.

Presentations to private sector/industrial audiences
Beyond those mentioned above, highlights in YR 9 include:


Documentary and Video/Media Projects

In 2013, CNS-ASU revamped its website (cns.asu.edu) with the goal to demonstrate CNS-ASU’s recognition that interdisciplinary and integrated communications about the societal dimensions of nanotechnology require a diverse outreach strategy. CNS-ASU thus continues to develop its new media project to infrastructure, workflows, and capacities. The goal of the project is to expand the reach of the Center’s regular research and engagements through a variety of media.

Our goal has been to video as much as possible and make it accessible to a broader audience through the website. To this end we have been producing videos of CNS’s Occasional Speaker series; they are available at: [http://vimeo.com/album/1542414](http://vimeo.com/album/1542414). We have been recording the CNS Science Café Series for several years as well, posting those videos at: [http://vimeo.com/album/1662457](http://vimeo.com/album/1662457). We have also tried to highlight specific faculty and projects by compiling short videos of them discussing their work. We have also disseminated the short films that Wetmore and Bennett developed for the Nano and Society workshop program.

Fixed

Regan Brashear, former CSPO filmmaker in residence, completed her film “Fixed: The Science/Fiction of Human Enhancement,” which generously credits CNS-ASU as assisting with the film. Over the course of making the film, she interviewed Center faculty including Guston and Miller, and the completed version includes significant footage of CNS collaborator Wolbring. Guston moderated a screening of the film at the S.NET annual meeting in Boston and it was scheduled to be shown at the upcoming EuroScience Open Forum in Copenhagen but appropriate arrangements could not be made. Guston will moderate a CNS-sponsored screening at the upcoming Governing Emerging Technologies meeting in May 2014.

Lab-Life

Filmmaker Frank Theys continues his work on a documentary film that involves the work of RTTA 4/STIR embedded humanists. The film is produced by Savage Films (Belgium) and Cobos Films (The Netherlands) in a coproduction with the public broadcaster ZDF/ARTE (Germany/France), supported by the Flemish and the Dutch Film Funds, the European MEDIA Program and the CERA Art Foundation. The director Theys expects a 90 minute cinematic release and a 60 minute television version to be distributed by Autlook Films (Austria).
13. Shared and other Experimental Facilities

While CNS-ASU has no physical science or engineering experimental facilities as such, it has created a nexus of exciting, cutting-edge inquiry that has drawn large numbers of scholars, many of them international, to visit and collaborate with us in a variety of capacities. The Center has a physically coherent space – integral with its parent center, the Consortium for Science, Policy and Outcomes (CSPO) – and sufficient capacity and flexibility to host visitors. To date, since beginning operation in Oct 05, and according to rigorous selection criteria, CNS-ASU has hosted numerous visitors including one hundred and two (102) international scholars, students, and policy practitioners from approximately two-dozen (24) countries. These numbers do not include dozens more international visitors to the Georgia Tech and University of Wisconsin-Madison sites, nor do they include some sixty-five (65) international visitors to the ASU Tempe campus who attended the 2011 S.NET conference and the 2013 Communities of Integration workshops. This section reports on the interactions that CNS-ASU has generated, which in turn point to the Center’s value as a destination for visiting international scholars and its role as the central node in a widening international network.

To provide meaningful structure for our reporting on these visits, we limit our account here to include only a subset of these interactions based on three rigorous selection criteria. First, we only report on visitors who come from outside the US to CNS-ASU in Tempe. Thus, in past years, we have not counted Bowman (Northern Ireland) or twelve other international visitors who attended the fourth STIR project workshop or three UK visitors who attended the US-UK dialogue on responsible innovation, since these meetings were both held in Washington DC. Second, we only report on visitors who have no formal positions within US institutions, whether at ASU or elsewhere. Thus, as in past years, we do not count international visitors such as Gjefsen, who currently have appointments at another US institution. Third, we only count one member of each group of two or more visitors from the same institution or country (except in cases where members engaged in separate Center interactions that did not involve the group as such). We thus have counted Naranjo (Ecuador) and Hosono (Japan), but not the other five scholar-practitioners who comprised the same South American and Japanese delegations, respectively.
In YRs 1-8, CNS-ASU was visited by ninety (90) international visitors who fit these criteria. Visits from these people varied in length of stay, ranging from a few days to several months, but in nearly every case the visitor provided a lecture or seminar on his or her work related to nanotechnology in society and met intensively with CNS-ASU researchers. These visitors included faculty, students, and policy practitioners.

In YR 9, the following ten CNS-ASU visitors fit the three criteria specified above:

1. Christian Beaudrie - University of British Columbia, Canada
2. Laura Cabrera - University of Basel, Switzerland
3. Silvia Casini - Università Ca' Foscari Venezia, Italy
4. Sarah Davies - University of Copenhagen, Denmark
5. Grace Eden - University of Oxford, U.K.
6. Steven Flipse - Technical University of Delft, Netherlands
7. Maria Karaulova - University of Manchester, U.K.
8. Harro Van Lente - Utrecht University, Netherlands
9. Georgia Miller - University of South Wales, U.K.
10. Sally Randles - University of Manchester, U.K.
11. Jie Ren - Beijing Institute of Technology, China
12. Roberto Toledo - INS HEA, France

YR 9 CNS-ASU visitors consist of twelve students/researchers who come from eight countries. Several YR 9 visitors are developing research plans that grow out of their interactions with the Center. Ten were participants in the Winter School. In general, all visiting graduate students receive mentorship from CNS-ASU researchers and most have opportunities to present and to publish.

Sample publications or publishing activity in YR 9 by previous international visitors to the Center that stemmed from or were shaped by their interactions with CNS-ASU include the following articles:


During YR 9, several instances of knowledge transfer, dissemination, and application occurred, including those mentioned in conjunction with the STIR project (see RTTA 4/2) and the ongoing
incorporation of Center ideas into EU and UK efforts aimed at Responsible Innovation (e.g., Stilgoe et al., 2013). After several visits to the US, Frank Theys continued filming the work of STIR “embedded humanists” within laboratories for his documentary entitled, 'Lab-Life'. (see RTTA 4/2). This is a documentary directed by Theys and produced by Savage Films (Belgium) and Cobos Films (The Netherlands) in a coproduction with the public broadcaster ZDF/ARTE (Germany/France), supported by the Flemish and the Dutch Film Funds, the European MEDIA program and the CERA Art Foundation. The film will have a cinema release (90 min.) and a 60 min. or series version for television and will be distributed by Autlook Films (Austria).

These activities and capacities have enabled CNS-ASU to become increasingly involved in arranging and participating in international events that take place outside of our physical space proper and that extend the reach and vibrancy of our network of partners and collaborators. They have also provided the template for activities anticipated under the proposal to NSF’s “Science Across Virtual Institutes” program for a “Virtual Institute for Responsible Innovation.”
**14. Personnel**

The Center is managed by a Director (Guston), three Associate Directors (Fisher, integration; Selin, anticipation; and Wetmore, engagement), and an Assistant Director (Bennett, education). An Executive Committee composed of the Center’s team leaders and institutional PIs meets monthly by phone. In addition to Guston (ASU) and Miller (ASU), Center co-PIs are Elizabeth Corley (ASU), to recognize her work across RTTAs, Dietram Scheufele (Wisconsin) and Jan Youtie (GA Tech) – to recognize the deep partnership with those subcontracting institutions. We have removed Deirdre Meldrum (ASU), who is now advisor to President Crow on special projects, as she was no longer active in our programs.

CNS-ASU has experienced significant turnover among its three full-time staff: Regina Sanborn, promoted two years ago from Program Manager to Assistant Director, took on a new challenge with ASU’s Engineering Research Center. In her place, CNS hired Deron Ash as Program Manager in October 2013. Michelle Iafrit, Program Coordinator, continues, and reports to Ash; and Daniel Hooker, Program Coordinator for communication, resigned for family reasons and CNS hired Jennifer Banks at 75% to coordinate communication for both CNS-ASU and VIRI.

CNS-ASU has a set of team leaders for each of its major RTTA and TRC research programs. These leaders are spread across the Center’s participating institutions and in some instances overlap with institutional leaders (see below). The team leaders currently are:

RTTA 1: Jan Youtie, GA Tech; Jose Lobo, ASU  
RTTA 2: Elizabeth Corley, ASU; Dietram Scheufele, Wisconsin  
RTTA 3: Cynthia Selin, ASU; Kelly Rawlings, USC  
RTTA 4: Erik Fisher, ASU; Elizabeth Corley, ASU

TRC 1: Jameson Wetmore, ASU; Susan Cozzens, GA Tech  
TRC 2: Armin Wiek, ASU; Sander van der Leeuw, ASU

This group convenes monthly in a telephone call as the Executive Committee. CNS-ASU also communicates internally through a regular lab meeting, held every other week, for personnel at ASU, and regular lab meetings held at similar intervals among the Wisconsin and GA Tech groups, as well as between GA Tech and ASU for TRC 1. A listserv dedicated to CNS-ASU affiliated personnel at all its institutions also facilitates communication.

Much of the interaction among CNS personnel is driven by both the preparation for and the consequences of the All-Hands meeting. The first All-Hands meeting, held 19-21 April 2007, involved more than fifty faculty and student researchers from the several universities involved in CNS-ASU, plus about one dozen specially selected nano-in-society scholars from outside of CNS. CNS-ASU held its second All-Hands meeting 23-25 Apr 08.

CNS-ASU held a Visioning Workshop in Oct 08 to engage in reflexive scrutiny of our future visions of anticipatory governance and RTTA. It included CNS-ASU research, education, and outreach leadership, as well as a few select outsiders and several of our NSE research collaborators. The meeting helped feed into the Center’s strategic planning process and prepared for the All Hands meeting.

CNS held its third All-Hands meeting on 14-16 Jan 09, the major focus of which was preparing for the renewal effort. Seventy individuals were in attendance representing ASU (researchers, students
and staff), CNS-affiliated universities (researchers and students), and others in the nano-in-society field. Our fourth All-Hands meeting was held 11-13 Jan 10, with sixty-four in attendance representing ASU (researchers, students and staff), CNS-affiliated universities (researchers and students), and several representatives from NISE Net. Our fifth All-Hands Meeting was held on 10-12 Jan 11, with fifty-seven in attendance representing ASU, CNS-affiliated researchers at other universities, several representatives from NISE Net, and a newly constituted Board of Visitors.

In the previous year, CNS-ASU held its All-Hands meeting – with 51 in attendance including its Board of Visitors – in conjunction with the 3rd Annual Meeting of the Society for the Study of Nanoscience and Emerging Technologies (S.NET), co-hosted by CNS-ASU and CNS-UCSB in Tempe, AZ on 7-10 Nov 11.

Last year, CNS-ASU held its first Winter School on the Anticipatory Governance of Emerging Technologies. Because all team leaders were present for the Winter School, the Center did not hold an official All-Hands meeting, but instead invited all graduate students in the Center to meet with both the Winter School participants and the Board of Visitors, with whom they engaged in a “speed dating poster session.”

In the current year, we repeated this organization of multiple meetings of the Center, the Board of Visitors, the Winter School and – specific to the current year – the group of Futurescape City Tours researchers. This overlap went over very well with all participants and we expect a similar arrangement in YR 10.

We also expect to organize a final meeting for the Center to which we would invite CNS-ASU “alumni/ae” back for a larger intellectual gathering.
CNS-ASU Organizational Structure
March 2013 – Present

Director
David Guston, CNS-ASU

Program Manager
Deron Ash

Program Coordinator:
Events and Administration
Michelle Iafrit

Program Coordinator:
Communications
Jennifer Banks

Graduate Research Assistants
Student Interns

Board of Visitors
(Multi-sector)

Associate Director
Integration
Erik Fisher

Associate Director
Anticipation
Cynthia Selin

Associate Director
Outreach
Jameson Wetmore

Assistant Director, Education
Ira Bennett

Post-Doctoral Scholars
Michael Reinsborough
Kathryn Vignone
Rider Foley

RTTA 1: Research & Innovation Systems
Jan Youle, GA Tech
Philip Shapiro, GA Tech
Jose Lobo, ASU

RTTA 2: Public Opinion & Values
Dietram Scheufele, UW-Madison
Elizabeth Corley, ASU

RTTA 3: Anticipation & Deliberation
Cynthia Selin, ASU
Kelly Rawlings, ASU

RTTA 4: Reflexivity & Integration
Erik Fisher, ASU
Elizabeth Corley, ASU

TRC 1: Equity & Responsibility
Susan Cozzens, GA Tech
Jameson Wetmore, ASU

TRC 2: Urban Design, Materials & the Built Environment
Arnim Wiek, ASU
Sander van der Leeuw, ASU
Table 4A: NSEC Personnel, Irrespective of Citizenship

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Table 4B: NSEC Personnel, U.S. Citizen or Permanent Resident

Primary NSEC support indicated by (‡) symbol. Partial NSEC support for all others.

Faculty level participants indicated in boldface.

Books


Book Chapters


Nanotechnology and the Challenges of Equity, Equality and Development, ed(s). Susan Cozzens and Jameson Wetmore, New York: Springer.


Peer Review Journal Article


10. ‡Anderson, Ashley A., Dominique E. Brossard, Dietram A. Scheufele, Michael A. Xenos and

11. ‡Anderson, Ashley A., Dominique E. Brossard, Dietram A. Scheufele, Michael A. Xenos and Sara
Communication and Society*.

12. ‡Anderson, Ashley A., Jason Delborne and Daniel L. Kleinman. 2012. "Information Beyond the
Forum: Motivations, Strategies, and Impacts of Citizen Participants Seeking Information during a

13. ‡Anderson, Ashley A., Jiyoun Kim, Dietram A. Scheufele, Dominique E. Brossard and Michael A.
Xenos. 2013. "What’s in a name? How we define nanotech shapes public reactions." *Journal of

Subsystems: Examining Discourse Effects of the 21st Century Nanotechnology Research and
http://dx.doi.org/10.1111/ropr.12033

15. ‡Arora, Sanjay, Alan L. Porter, Jan Youtie and Philip Shapira. 2013. "Capturing Developments in
an Emerging Technology: an Updated Search Strategy for Identifying Nanotechnology Research

16. ‡Arora, Sanjay, Jan Youtie, Philip Shapira, Lidan Gao and Tingting Ma. 2013. "Entry Strategies in
an Emerging Technology: a Pilot Web-based Study of Graphene Firms." *Scientometrics*. 95(3):1189-
1207.

17. ‡Arora, Sanjay K., Jan Youtie, Stephen Carley, Alan L. Porter and Philip Shapira. 2014.
"Measuring the Development of a Common Scientific Lexicon in Nanotechnology." *Journal of

18. ‡Arora, Sanjay, Rider W. Foley, Jan Youtie, Philip Shapira and Arnim Wiek. 2014. "Drivers of
Technology Adoption: Nanomaterials in Building Construction." *Technological Forecasting and


74. ‡**Foley, Rider W. and Arnim Wiek.** In review. "Scenarios of Nanotechnology Innovation vis-à-vis Sustainability Challenges." *Futures.*


181. ‡Su, Leona Yi-Fan, **Heather E. Akin, Dominique E. Brossard,** Ashley A. Anderson and **Dietram A. Scheufele.** In review. "Science Audience Tectonics: News Consumption Pattern and it's Implication for Public Understanding of Science." *Journalism and Mass Communication Quarterly.*


213. **Ye, Sara K., Xuan Liang, Dominique E. Brossard and Michael A. Xenos**. In review. "Is the Online Environment Changing the Construction of Scientific Controversies?" *Public Understanding of Science*.


221. ‡Youtie, Jan, Stephen Carley, Philip Shapira, Elizabeth A. Corley and Dietram A. Scheufele. In review. "Perceptions and Actions: Examining the Relationship between Views on Risk and Citation Actions of Nanotechnology Scientists." *Risk Analysis*.


**Trade Journal Article**


7. ‡Scheufele, Dietram A. 2006. "If We Are to Communicate Successfully With the Public, We Need to Learn How to Frame the Message for Different Audiences." *Materials Today*. 9(5):64.


Other Journal Article


**Periodical (popular magazines, newspapers)**


**Internet**


62. Wetmore, Jameson. December 3, 2012. "We're becoming a Bit More Amish." As We Now Think. http://aswenowthink.wordpress.com/2012/12/03/were-becoming-a-bit-more-amish/


**Report**


32. Van Horn, Carl, Jennifer Cleary, Leela Hebbar and Aaron Fichtner. 2009. A Profile of Nanotechnology Degree Programs in the United States.#R09-0001 John J. Heldrich Center for Workforce Development. Rutgers, The State University of New Jersey. New Brunswick, NJ.


**Working Papers**


40. ‡Youtie, Jan, Philip Shapira and Juan D. Rogers. 2009. "Nanotechnology-Enhanced Thin-Film Solar Cells: Analysis of Global Research Activities with Future Prospects."


Thesis/Dissertation


33. ‡Lowder, Jessica. 2008. "Creating Sustainable Solutions with Nanotechnology, Energy, and Equity
Tempe, AZ.

34. ‡Lucivero, Federica. 2012. "Too Good to be True? Appraising Expectations for Ethical Technology

35. ‡Lull, Madeline. 2008. "Innovation Space Strategic Marketing Plan for Braille PDA." Undergraduate


Undergraduate Thesis. Barrett Honors College. Arizona State University. Tempe, AZ.

38. ‡Mellinger, Michelle. 2011. "Innovation Space and The Center for Nanotechnology in Society:
Arizona State University. Tempe, AZ.


University. Tempe, AZ.

Approach." Master’s Thesis. Department of Mathematics. Arizona State University. Tempe, AZ.

42. Philbrick, Mark. 2010. "Operationalizing Anticipatory Governance: Steering Emerging Technologies
Towards Sustainability." Doctoral Dissertation. Graduate Division. University of California,
Berkeley. Berkeley, CA.

43. Pirtle, Zach. 2007. "Democratizing Nanotechnology: Intersecting the Philosophy of Science with

44. ‡Reed, Jaron. 2010. "A Geospatial Analysis of Fast-Food Outlets and Demographic Variables in
Arizona State University. Tempe, AZ.


46. ‡Runge, Kristin. In review. 2014. "Social Science: Investigating the Effects of Interpersonal
University of Wisconsin-Madison. Madison, WI.


Presentations


211


89. **Corley, Elizabeth A.** April, 2008. "Scientists and the Public: Comparing Views on Nanotechnology Risks and Regulations." Talk. CSPO Enlightening Lunch, Arizona State University, Tempe, AZ.


100. Cortes Lobos, Rodrigo. May, 2011. "Can Agri-food Nanotechnology contribute to achieve the Millennium Development Goals in Developing Countries?" Presentation. 7th International Globelics Academy, Tampere, Finland.


188. **Fisher, Erik.** September, 2007. "Integrating Social Considerations into Nanotechnology Research." Presentation. 1st Rocky Mountain Nanotechnology Showcase, Denver, CO.


199. **Fisher, Erik.** November, 2006. "Reflecting on the Shape of Nanotechnology Research from Within." Presentation. 4S Conference (Society for Social Studies of Science), Vancouver, Canada.


231. Gallo, Jason. April, 2007. "The National Science Foundation and the Control of Information." Department of Life Sciences Communication colloquium series, University of Wisconsin, Madison, WI.


297. **Guston, David H.** March, 2009. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Video lecture. Graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.


303. **Guston, David H.** February, 2008. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Video lecture. Graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.


311. **Guston, David H.** May, 2006. "What Do We Want to Learn from Public Participation in Nanotechnology?" Presentation. NNI Public Participation in Nanotechnology Workshop, Arlington, VA.


314. **Guston, David H.** February, 2006. "Anticipatory Governance at the Center for Nanotechnology in Society at ASU." Video lecture. Graduate class in Science and Technology Policy, Ford School of Public Policy, University of Michigan, Ann Arbor, MI.


346. Ho, Shirley S., Xuan Liang, Dominique E. Brossard, Dietram A. Scheufele, Michael A. Xenos, X. Hao and X. He. June 2013. "Value Predispositions as Perceptual Filters: A Cross-cultural Comparison


356. **Jacobs, Bert** and **Jameson Wetmore.** March 23, 2007. "Transferring Western Technology to Developing Countries: Good Intentions, Unexpected Outcomes." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.


400. **Maracas, George, Patrick Phelan** and **Braden Allenby**. September 19, 2008. "Is Nanotechnology Good for Sustainability or Not." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.


411. Meng, Yu. April, 2009. "Female Involvement in Nanotechnology Patenting: Does it make a Difference." Presentation. Workshop on Original Policy Research, School of Public Policy, Georgia Institute of Technology, Atlanta, GA.


416. Miller, Clark A. 2012. "Nanotechnology, the Brain, and the Future." Keynote Lecture. Integrating Nanotechnology with Cell Biology and Neuroscience Symposium, University of New Mexico, Albuquerque, NM.


428. **Miller, Clark A.** March, 2006. "Nanotechnology in Society." Presentation. Ohio State University, Columbus, OH.


432. **Miller, Thaddeus R.** February 26, 2014. "Futurescape City Tours: Public Engagement in the City." Presentation. President’s Umbrella Tours. PSU.


460. **Porter, Alan L., Philip Shapira and Jan Youtie.** September, 2006. "Defining the Nanotechnology Domain in a Real Time Technology Assessment." Presentation. Technology Transfer Society Annual Conference, Atlanta, GA.


Presidential Election." Paper Presentation. The Annual Convention of the American Association for Public Opinion Research, Boston, MA.


511. Scheufele, Dietram A. January 17, 2014. "Why Polarized Debates used to be Good for us." Presentation. TEDxUWMadison. Madison, WI.


520. Scheufele, Dietram A. May 9, 2013. "Barriers to Addressing Our Climate and Energy Challenges." Presentation. Panelist at Wisconsin Academy of Science, Arts & Letters. Madison, WI.


552. **Selin, Cynthia.** March 14, 2011. "Rethinking Urban Governance: Knitting together Foresight and Sustainability." Presentation. Resilience, Innovation and Sustainability: Navigating the Complexities of Global Change, Tempe, AZ.


571. **Selin, Cynthia.** February, 2008. "Evidencing the Future and other Dilemmas Working in the Future Tense." Presentation. Anthropology Department, Rice University, Houston, TX.


611. **Shapira, Philip** and **Jan Youtie.** December 07, 2012. "Interpreting Trajectories of Nanotechnology Research and Innovation (and, is there a "Nanotechnology Paradox?")." Presentation. Center for Nanotechnology in Society at Santa Barbara, Santa Barbara, CA.


615. **Shapira, Philip, Jan Youtie** and **Alan L. Porter**. November 11, 2011. "Trajectories of Global Nanotechnology Commercialization." Presentation. IGERT Seminar, Georgia Institute of Technology, Atlanta, GA.


699. **Wetmore, Jameson.** April 03, 2010. "Nanodays-Student Presentations of Basic Science and Nanotechnology Applications." Arizona Science Center, Phoenix, AZ.


705. **Wetmore, Jameson.** November 08, 2009. "Technology and the City." Presentation. On the Cutting Edge...Today's Jewish Women Symposium, Scottsdale, AZ.


713. **Wetmore, Jameson.** November, 2008. "Nanotechnology the Promise, Politics, and Personal Impacts." Presentation. Presentation to the Women's Symposium, co-sponsored by the Jewish Studies Department at Arizona State University and the Bureau of Jewish Education of Greater Phoenix, Phoenix, AZ.


716. **Wetmore, Jameson.** April, 2008. "What Do You Think About a Technology You Can’t Even See." Presentation. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.


720. **Wetmore, Jameson.** September, 2007. "Bureaucrats, Lobbyists, and Regulators, Oh My! Introducing Graduate Students to Science Outside the Lab." Presentation. CSPOs Enlightening Lunch, with Ira Bennett, Arizona State University, Tempe, AZ.


723. **Wetmore, Jameson.** March, 2007. "Transferring Western Technology to Developing Countries: Good Intentions, Unexpected Outcomes." Presentation. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.


733. White, Dave and Troy M. Benn. May 15, 2009. "To Drink or Not to Drink: What Should We Do to Have Good-Tasting, Safe and Sustainable Water into the Future." Talk. CNS-ASU Science Cafe, Arizona Science Center, Phoenix, AZ.


793. Youtie, Jan, Philip Shapira, Thomas Heinze and Juan D. Rogers. October, 2009. "Highly Creative Research: How it is defined and Organized." Presentation. 2009 Atlanta Conference on Science and Innovation Policy, Atlanta, GA.


Other


58. Reifschneider, Kiera. April 11, 2012. "'Speed Date a Scientist' Event Recap."


80. ^Wetmore, Jameson. 2010. "Series of Five Informational Sheets on the Social Implications of Nanotechnology (with other Collaborators)." Distributed by the Nanoscale Informal Science Education Network to Museums Across the Country for Nanodays and Other Programs.


**Search and Mapping Tools and Thesauri**


2. Carley, S. (October, 2009). Citation Counter Macro for Vantage Point and Web of Science.

3. Carley, S. (January, 2010,). Citation Extractor Macro for Vantage Point and Web of Science.


Press


   a) February 1, 2013 – NPR. http://www.npr.org/2013/02/01/170855378/preserving-science-news-in-an-online-world


a) May 2011 – Science Index.
http://scienceindex.com/stories/1655760/From_enabling_technology_to_applications_The_evolution_of_risk_perceptions_about_nanotechnology.html


http://downtowndevil.com/2012/12/10/36475/futurescape-city-tour-nanotechnology/


   - March 30, 2010 – NanoCEO. [http://www.nanoceo.net/nanonews_03_30_10](http://www.nanoceo.net/nanonews_03_30_10)


a) November 30, 2010 – Slideshare. http://www.slideshare.net/seforaDOTorg/sea-virtual-
seminar-david-guston-nov-30-700-pm-et

55. Guston, David H. December 15, 2010. Cluster One Highlights: Toward the Regulation of

– Social Studies of Science. http://sss.sagepub.com/reports/most-cited

57. Guston, David H. January 7, 2011. 2010 – That was the year that was. Fondazione Giannino
Bassetti. http://www.fondazionebassetti.org/en/focus/2011/01/2010_-_that_was_the_year_that.html


      http://asunews.asu.edu/20110223_nanomonoshow


      http://www.nas.org/articles/Programming_Scientists_to_Perform_Social_Engineering

scientists-to-perform-social-engineering/

http://www.techconnect-


Press.

63. Hall, Hollie. September 17, 2010. Science Outside the Lab. Integrative Graduate Education and


65. Harsh, Matthew. May 12, 2011. Careful design is key to success of development prizes. Science and
Development Network. http://www.scidev.net/en/opinions/careful-design-is-key-to-success-of-
development-prizes-1.html


   e) December 8, 2009 – InterNano. http://www.internano.org/content/view/325/95/


   

   


92. **Scheufele, Dietram A.** March 8, 2013. A brave new (online) world: Emerging technologies at the intersection of science, policy, and rapidly changing media environments. Talk.


98. **Tillery, Stephen Helms** and **Robert, Jason.** May 2012. Thinking with the mind’s eye. ASU Magazine


   c) September 2012 – ASU Magazine


**Invention Disclosure**


16. Biosketches

New investigators for this grant year include the following Futurescape collaborators:

1. Krista Harper - associate professor, Univ. of Massachusetts, Amherst
2. Thaddeus Miller – assistant professor, Portland State University
3. Roopali Phadke – associate professor, Macalester College

Please note that their biosketches follow in this section.
PROFESSIONAL PREPARATION
University of California, Santa Cruz, Anthropology, MA 1994, PhD, 1999
University of California, Berkeley, Anthropology (Minor in French), BA, 1992

APPOINTMENTS
University of Massachusetts Amherst, Department of Anthropology
2010-present Associate Professor and Director of the European Field Studies Program.
2004-present Assistant Professor and Director of the European Field Studies Program (since Fall 2007),
2003-2004 Visiting Assistant Professor.
1999-2002 Postdoctoral Fellow, Political Economy Research Institute, University of Massachusetts Amherst.
Smith College, Department of Anthropology
2002-2003 Visiting Assistant Professor, Department of Anthropology, Smith College.

SELECTED PUBLICATIONS RELATED TO PROJECT

OTHER SELECTED PUBLICATIONS
SYNERGISTIC ACTIVITIES
Director, European Field Studies Program, Department of Anthropology, University of Massachusetts Amherst. 2007-present. Field supervisor, 2006-2007 and 2012-2013.
Associate professor (joint appointment) and research committee member, Center for Public Policy and Administration, University of Massachusetts Amherst. 2004-present.
Steering committee member, Institute for Social Sciences Research (ISSR), College of Social and Behavioral Sciences, University of Massachusetts Amherst. Spring 2012-present.
Faculty affiliate, Center for Heritage and Society, University of Massachusetts Amherst. Search committee member (2009-2010).

COLLABORATORS & OTHER AFFILIATIONS
Co-authors and collaborators (past 48 months):
Ana Isabel Afonso, Department of Anthropology, New University of Lisbon
Roberta Garner, Department of Sociology, De Paul University.
Aline Gubrium, School of Public Health, University of Massachusetts Amherst.
Barbara Rose Johnston, Center for Political Ecology, University of California, Santa Cruz.
D. Seth Murray, Divisions of Interdisciplinary Studies, North Carolina State University.
Catherine Sands, Center for Public Policy and Administration, University of Massachusetts Amherst.
Andria Timmer, Department of Anthropology, Christopher Newport University.
Jacqueline Urla, Department of Anthropology, University of Massachusetts Amherst.
Ismael Vaccaro, Department of Anthropology, McGill University

Graduate advisors:
Donald Brenneis, Department of Anthropology, University of California, Santa Cruz.
S. Ravi Rajan, Department of Environmental Studies, University of California, Santa Cruz.
Anna Tsing, Department of Anthropology, University of California, Santa Cruz.

Graduate Student Advisees, Department of Anthropology, University of Massachusetts Amherst (15)
Rebecca Broedel (PhD in progress); Fabiola del Castillo (MA 2007); Jamie Fisher (MA in progress); Robin Gray (MA 2010); Kamela Heyward (PhD 2012); Theresa Hyland (MA 2008); Mackenzie Jackson (MA in progress); Dana Johnson (chair, MA 2012, PhD in progress); Mary Larkum (PhD in progress); Alanna Lynch (MA 2009); Vanessa Martinez (PhD 2014); Alin Rus (chair, PhD in progress); Ann Stewart (MA 2008); Chris Sweetapple (MA 2008, PhD in progress); Danica Willis (chair, MA 2009).

Graduate Student Committees, Other Departments and Universities (18)
Bengi Akbulut, Economics (PhD 2010); Daniel Burland, Sociology (MA 2008, PhD 2011); Josh Carreiro, Sociology (PhD in progress); Jessica Carrick-Hagenbarth, Economics (PhD in progress) Janelle Cornwall, Geography (PhD 2011); Nikolina Dobreva, Comparative Literature, (PhD 2009); Richard Filcak, Environmental Sciences and Policy, Central European University (PhD 2007); David Habashi-Boromisza, Communication (PhD 2008); Harry Konstantinidis (PhD 2012); Economics; Camille Martinez, Communication (PhD in Progress); Simona Perry, Natural Resources Conservation (PhD 2009); Emily Polk, Communication (PhD 2013); Robert Ricard, Natural Resources Conservation (PhD 2009); Andria Timmer, Anthropology, University of Iowa (PhD 2009); Shawn Trivette, Sociology (PhD 2012); Ted White, Geosciences (PhD 2013); Elsa Wiehe, International Education (PhD 2013).
Biographical Sketch

Thaddeus R. Miller, Ph.D.

Professional Preparation

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<td>Environmental Studies and Economics</td>
<td>B.A.</td>
<td>2003</td>
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<td>Columbia University</td>
<td>Environmental Science and Policy</td>
<td>M.P.A.</td>
<td>2004</td>
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<td>Arizona State University</td>
<td>Sustainability</td>
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Appointments

• **Assistant Professor** (2011-present), Urban Civic Ecology and Sustainable Communities, Nohad A. Toulan School of Urban Studies and Planning, College of Urban and Public Affairs, Portland State University.

• **Affiliate** (2014-present), Consortium for Science, Policy, and Outcome (CSPO), Arizona State University.

• **Associated Faculty** (2011-present), Ecosystems Services in Urbanizing Regions (ESUR) National Science Foundation Integrative Graduate Education and Research Training (IGERT) Program, Portland State University.

• **Faculty Fellow** (2011-present), Institute for Sustainable Solutions, Portland State University.

• **NSF IGERT in Urban Ecology Senior Fellow** (2008-2010), School of Sustainability, Arizona State University.

Products

(i) Relevant products


(ii) Other products


Synergistic Activities

- **Reconstructing Sustainability Science: Knowledge and Action for a Sustainable Future.** This is a book project that explores, through discourse analysis and interviews with leading scientists in the US, UK, Canada, Netherlands, Sweden and Japan, the emerging field of sustainability science. It is under contract with Routledge: Earthscan in the Science in Society Series (edited by Steve Rayner) and will be published fall 2014.

- **Conference Co-Chair,** Conference for Sustainability IGERTs, September 2013, Portland, OR. The ESUR IGERT program at Portland State University hosted the third national Conference for Sustainability IGERTs (Miller also co-chaired the second such conference at ASU as a doctoral candidate). Funded by a supplemental grant from NSF, the conference funded IGERT students and faculty from around the country focused on sustainability to convene for three days.

- **Principal Investigator and Workshop Chair,** Linking Socio-Environmental Knowledge to Socio-Environmental Change. National Socio-Environmental Synthesis Center (SESYNC) Workshop, October 10-11, 2012, Washington, D.C. Miller convened and coordinated a two-day workshop at SESYNC with 25 scientists and scholars from through the US, Canada and Europe (and one from South Africa). Participants explored the social, political and technological barriers to linking scientific knowledge to action for sustainability.

- **Principal Investigator** (2012-present), Community Watershed Stewardship Program, Portland Bureau of Environmental Services, $59,000/year, ongoing. In partnership with the City of Portland, Miller oversees the awarding and management of watershed stewardship grants to local community groups and organizations as well as the work of three graduate research assistants.

Collaborators and Other Affiliations

**Collaborators and Co-Editors:** Michael M. Crow, Arizona State University; Elise Granek, Portland State University; Jack Kittinger, Stanford University; David Kriebel, University of Massachusetts, Lowell; Derk Loorbach, Erasmus University; Amy Lubitow, Portland State University; Clark Miller, Arizona State University; Tischa Muñoz-Erickson, National Forest Service; Mark Neff, Allegheny College; Lennart Olsson, Lund University; Charles L. Redman, Arizona State University; John Robinson, University of British Columbia; Daniel Sarewitz, Arizona State University; Cynthia Selin, Arizona State University; Arnim Wiek, Arizona State University

**Graduate Advisors:** Ben. A. Minteer, Arizona State University (Chair); Charles L. Redman, Arizona State University; Daniel Sarewitz, Arizona State University; Arnim Wiek, Arizona State University

**Thesis Advisor:** All PSU doctoral students: Erin Goodling (Co-advisor, Urban Studies, Portland State University), Anthony Levenda (committee member, Urban Studies), Jackyn Kohon (committee member, Urban Studies), Marissa Matsler (committee member, Urban Studies), Paul Manson (committee member, Public Affairs), Zbigniew Grabowski (committee member, Environmental Science and Management), Dick Sperry (committee member, Technology Management).
Biographical Sketch

Roopali Phadke
Associate Professor, Environmental Studies
Macalester College
1600 Grand Avenue, Saint Paul, MN 55105
Ph: 651 696 6802 Fax: 651 696 6443
Email: phadke@macalester.edu

A. Professional Preparation

| Harvard University (Kennedy School) | Science & Tech Studies | Postdoc 2003-2005 University of California, Santa Cruz | Environmental Studies | PhD, 2003 |
| Cornell University | Asian Studies | MA, 1998 |
| Wellesley College | Political Science | BA, 1994 |

B. Appointments

Associate Professor, Environmental Studies Department, Macalester College (Sept 2005 - present)
Teaching and research related to environmental politics, science and technology policy, international development studies.

NSF Postdoctoral Fellow, Science, Technology and Society Program, Harvard University,
Kennedy School of Government (Sept 2003 – August 2005)
Under the mentorship of Dr. Sheila Jasanoff, conducted research on governance, technology policy and international development.

Researcher, Environmental Governance Project, UC Santa Cruz (Sept 2002 to June 2003)
Responsible for water sector research for this NSF funded project, including case study identification and analysis. Deliverables included book chapter, literature review and resource guide.

C. Publications


D. Synergistic Activities

At Macalester College, Dr. Phadke has been an active member of the President’s Climate Commitment Committee, the Institute for Global Citizenship, the Community Banking Advisory Committee, and the Lilly Project in Vocation and Ethical Leadership. She is also a Fellow with MN2020 and the City Arts Collaboratory.

Dr. Phadke serves as a reviewer for the Social Studies of Science, Society & Natural Resources, Science, Technology & Human Values, Ethics, Place and Environment, Agriculture & Human Values, and MIT Press.
Dr. Phadke holds professional memberships in the Society for Social Studies of Science, the Science and Democracy Network, Association of American Geographers and the Association for Environmental Studies and Sciences. She is a member of the Board of Trustees for the International Honors Program, an affiliated program of World Learning, Inc. She has also served as a Senior Panelist for the National Science Foundation.

F. Collaborators

Collaborators and Co-Editors: Ravi Rajan (UC Santa Cruz), Sheila Jasanoff (Harvard University), Michael Watts (UC Berkeley), Clark Miller (Arizona State University), Nicole Ardoiu (Stanford University), Noah Feinstein (UW Madison), Matt Turner (UW Madison), Mara Goldman (CU Boulder), Dustin Mulvaney (San Jose State), Christopher Bacon (Santa Clara), Max Boykoff (CU Boulder), Frank Laird (University of Denver), Cynthia Selin (ASU), Jason Delborne (NC State).
17. Honors and Awards

Barandiaran, Javier. Accepted Assistant Professor position in the Global Studies program at the University of California, Santa Barbara. September 2013.


Brossard, Dominique. Elected Officer of the American Association for the Advancement of Science (AAAS). January 2014.

Kim, Youngjae. Received SNO Conference Student Award. Kim is a doctoral student in ASU’s School of Public Affairs. September 2013.


Scheufele, Dietram A. Received Kellett Award from the Wisconsin Alumni Research Foundation. January 2014.

Xenos, Michael A. Appointed Chair of the Department of Communication Arts, University of Wisconsin-Madison. January 2014.

Youtie, Jan and Porter, Alan. Recognized as top 45 researchers of technology and innovation management from the International Association of Management of Technology based on a quantitative analysis of articles from 2008-2012. September 2013.
20. Leverage

The Center for Nanotechnology in Society at Arizona State University (CNS-ASU) has developed over its nine years in operation relationships/partnerships with two hundred seventy-two (272) academic partnering institutions and two hundred thirty-seven (237) non-academic partnering institutions, both domestic and international. The partners are listed in Table 6, at the end of this section.

Arizona State University (ASU) provides salary support for most of the faculty who work on CNS-ASU projects. Table 5 shows the amount of financial support CNS-ASU will receive from ASU and its subawards (Georgia Institute of Technology and University of Wisconsin, Madison) between September 1, 2013 and August 31, 2014.

Some successful partnerships include:

1. Consortium for Science, Policy and Outcomes (CSPO) – CNS-ASU receives support from CSPO that includes office space, desktop computers for all CNS-ASU faculty, staff, post-doctoral associates, and students, as well as access to servers, laptop computers, printers, copiers, scanners, projectors, fax machine, telephones, and a conference room with videoconferencing capability. CSPO also provides back-up for CNS-ASU staff.

2. Emerge 2013 Conference: The Future of Truth – was a special event held on February 28-March 2, 2013, uniting artists, engineers, bio-scientists, social scientists, storytellers, and designers to build, draw, write, and rethink the future of the human species and the environments that we share. Together, participants created provocative and evocative stories, games, performances, and objects from which a vision of our future emerges.

   The developers of Emerge were Joel Garreau (Lincoln Professor of Law, Culture and Values at the Sandra Day O’Connor College of Law; Director, “The Prevail Project: Wise Governance for Challenging Futures”), Ed Finn (Assistant Professor, School of Arts, Media and Engineering, and the Director of the Center for Science and the Imagination), Daniel Sarewitz (Professor, School of Life Sciences, and Co-Director of the Consortium for Science, Policy and Outcomes), and Braden Allenby (President’s Professor and Lincoln Professor of Engineering and Ethics, and School of Sustainable Engineering and the Built Environment).

3. Innovation Space -- an entrepreneurial joint venture among the Herberger Institute for Design and the Arts, the Ira A. Fulton Schools of Engineering, and the W.P. Carey School of Business at ASU. The goal of this transdisciplinary education and research lab is to teach students how to develop products that create market value, while serving real societal needs and minimizing impacts on the environment. Students learn to create products that are progressive, possible, and profitable, which also have a meaningful impact on the daily lives of ordinary people. Innovation Space utilizes two fundamental strategies for creating sustainable innovation: a model of new product development known as Integrated Innovation and the emerging field of biomimicry. CNS-ASU contributes $30,000 annually to this endeavor.
4. The Biodesign Institute – plays a critical role in advancing the research mission of ASU to conduct use-inspired research, fuse intellectual disciplines, and value entrepreneurship. Encompassing 350,000 square-feet of award-winning, state-of-the-art, LEED-certified buildings, the Biodesign Institute represents the State of Arizona’s largest research infrastructure investment in bioscience-related research. ASU is the first university in the US to create an interdisciplinary research institute entirely devoted to bio-inspired innovation principles, representing a vast expansion of ASU’s state-of-the-art research capacity, and also serving a core mission to engage the talents of its multidisciplinary scientists to find solutions to some of society’s largest challenges. The three major areas in which the Biodesign Institute is working to make a difference are: biomedicine & health outcomes, sustainability, and security. This framework allows the Institute to address these critical global challenges by creating “use-inspired,” as well as “bio-inspired” solutions.

CNS-ASU and the Biodesign Institute offer fellowships to two graduate students. The purpose of this program is to train students to work in cross-functional teams toward real-world outcomes. Since all research has implications beyond the laboratory, CNS-ASU invests in graduate students to study some of these outcomes by paying a percentage of their salary, employee related expenses, and tuition. CNS-BDI Fellows participate in CNS-ASU sponsored curricular and co-curricular activities, including special courses, seminars, lectures, science cafes, and other opportunities, in addition to adding a “societal implications” chapter to their dissertation, the “PhD plus” component, which discusses the societal context of their research.

5. Ira A. Fulton Schools of Engineering – play a pivotal role in producing engineers and innovations to address the changing needs of society. FSE emphasizes problem-solving, innovation, entrepreneurship, multi-disciplinary interactions, societal context and connections. FSE ranks in the top 50 engineering schools in the United States, and offer 15 degree programs. It also is one of the largest engineering schools, with more than 200 faculty, more than 7,700 students, and more than $78 million in externally funded research. CNS-ASU and FSE offer fellowships to two graduate students. The purpose of this program is to train students to work in cross-functional teams toward real-world outcomes. Since all research has implications beyond the laboratory, CNS-ASU invest in graduate students to study some of these outcomes by paying a percentage of their salary, employee related expenses, and tuition. CNS-FSE Fellows participate in CNS-ASU sponsored curricular and co-curricular activities, including special courses, seminars, lectures, science cafes, and other opportunities, in addition to adding a “societal implications” chapter to their dissertation, the “PhD plus” component, which discusses the societal context of their research.

6. Barrett Honors College - Barrett students have the unique advantage of experiencing a small, intellectually, and socially vibrant environment, while having access to the vast resources of the major research university at ASU. Barrett students simultaneously benefit from being with others of the same intellectual preparation and commitment, and enjoy the advantages of a university environment actively engaged in exploring all areas of human interest and concern. All students who enter ASU through Barrett, The Honors College, also enroll in a disciplinary college, and pursue one or more of the 275+ available disciplinary majors and concentrations. Their education is the result of the integration of all colleges at ASU, including Barrett, that cultivate the talents and interests of Barrett students and endeavor to meet their changing needs as they develop academically and socially. Barrett students, hired as CNS-ASU student interns, participate in the CNS-ASU poster session at the
All Hands Meeting and the site visit from the National Science Foundation. Barrett students who have worked with CNS-ASU have gone on to win Fulbright fellowships and Presidential Management Fellowships.

8. Center for Science and the Imagination – brings writers, artists, and other creative thinkers into collaboration with scientists, engineers, and technologists to reignite humanity’s grand ambitions for innovation and discovery. CNS-ASU partnered with CSI to present a lecture on human enhancement and the singularity in the reporting year. CSI is also working with CSPO and CNS-ASU on the Frankenstein Bicentennial Project.

9. University of Notre Dame – and CNS-ASU will host a collaborative research workshop on the “Anticipatory Governance of Complex Engineered Nanomaterials,” including advanced generation nanosystems. The workshop will be a joint effort of the Centers for Environmental Implications of Nanotechnology, the Centers for Nanotechnology in Society, the Center for Nano Science and Technology, and other relevant groups. The workshop will generate new knowledge about the prospective governance challenges of CENMs, and will take full advantage of the dissemination abilities of the centers and/or groups involved.

10. Nanoscience and Emerging Technologies in Society: Sharing Research and Learning Tools (NETS) project – investigates digital resources to advance the collection, dissemination, and preservation of this body of research, addressing the challenge of marshaling resources, academic collaborators, appropriately skilled data managers, and digital repository services for large-scale, multi-institutional and disciplinary research projects. The central activity of this project involves a workshop that will gather key researchers in the field and digital librarians together to plan the development of a disciplinary repository of data, curricula, and methodological tools. Partners include CNS-ASU, CNS-UCSB, University of Michigan’s Inter-University Consortium for Political and Social Research, and the University of Massachusetts, Amherst Libraries.
TABLE 5: Other Support  
(NSF Grant #093791)

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<th>Year 3 9/15/12-9/14/13</th>
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Table 6: Partnering Institutions (cumulative)

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<th>Name of Institution</th>
<th>Receives Financial Support from Center</th>
<th>Contributes financial support to the center</th>
<th>Minority Serving Institution Partner</th>
<th>Female Serving Institution Partner</th>
<th>National Lab/other gov't Partner</th>
<th>Industry Partner</th>
<th>Museum Partner</th>
<th>International Partner</th>
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### I.a. Academic Partnering Institutions (ASU)

- Arizona Institute for Nano-Electronics (AINE)
- Arizona Technology Enterprises (AZTE)
- Axon Technologies
- Barrett, The Honors College
- Biodesign Institute
- Center for Biology & Society
- CRESMET
- Center for the Study of Religion and Conflict
- Center for Law, Science and Innovation
- Center for Science and the Imagination
- Center for Solid State Electronics Research
- Center for Study of Institutional Diversity
- College of Liberal Arts and Sciences
- College of Public Programs
- College of Technology & Innovation
- Complex Adaptive Systems Initiative (CASII)
- Consortium for Science, Policy and Outcomes
- Decision Theater for a Desert City
- Foundation, ASU
- Global Institute of Sustainability
- Graduate College
- Hayden Library
- Health Services
- Herberger Institute for Design and the Arts
- Hispanic Research Center
- Ira A. Fulton Schools of Engineering
- Learning Sciences Institute
- LightWorks
- Mary Lou Fulton School of Education
- New Interdisciplinary Arts & Sciences
- Office of China Initiatives and Strategy
- Office of Knowledge and Enterprise Development (OKED)
- Office of Public Affairs
- Office of the President
- Office of Vice President and Provost
- Office of University Initiatives
- Occupational Health and Safety
- Phoenix Urban Research Laboratory
- SOLCS-Responsible Conduct of Research Program
- Sandra Day O'Connor School of Law
- School of Earth & Space Exploration
- School of Government, Politics, and Global Studies
- School of Human Evolution and Social Change
- School of International Languages and Cultures
- School of Letters and Sciences
- School of Life Sciences
- School of Mathematical and Statistical Sciences
- School of Philosophical, Historical, and Religious Studies
- School of Social Transformation
- School of Sustainability
- Science Policy Assessment and Research on Climate (SPARC)
- Stardust Center
- Technology Based Learning Research
- Transformative Healthcare Networks
- University Art Museum
- University Public Schools
- W.P. Carey School of Business
- Walter Cronkite School of Journalism and Mass Communication

### I.b. Academic Partnering Institutions

- Aarhus University, Denmark
- Aarhus Institute of Denmark
- Antwerp University
- Austrian Academy of Science
- Baylor College of Medicine
- Beijing Institute of Technology, China
- Bioscience High School
- Boise State University
- Bowling Green State University
- Brown University
- California State University, Sacramento
- Cardiff University
- Carnegie Mellon University
- Case Western Reserve University
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272 Total Number Academic Partners

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<td>Will Bruder &amp; Partners Ltd.</td>
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<td>Winnipeg Art Gallery</td>
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<td>Woodrow Wilson International Center for Scholars</td>
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</tbody>
</table>

237 Total Non-academic Partners:
21. Current and Pending Support

Following are the Current and Pending Support documents for the PI and all thrust leaders:

1. Ira Bennett – Assistant Director, Education
2. Elizabeth A. Corley – co-PI; RTTA 2 co-team leader
3. Susan Cozzens – TRC 1 co-team leader
4. Erik Fisher – RTTA 4 team leader; Associate Director, Integration
5. David H. Guston – PI and Center Director
6. Jose Lobo – RTTA 1 co-team leader
7. Clark Miller – co-PI; Center Associate Director
8. Dietram Scheufele – co-PI; RTTA 2 co-team leader
9. Cynthia Selin – RTTA 3 co-team leader; Associate Director, Anticipation
10. Philip Shapira – RTTA 1 co-team leader
11. Sander E. van der Leeuw – TRC 2 co-team leader
12. Jameson M. Wetmore – TRC 1 co-team leader; Associate Director, Engagement
13. Arnim Wiek – TRC 2 co-team leader
14. Jan Youtie – co-PI; RTTA 1 co-team leader
### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Ira Bennett</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Support:</strong></td>
<td><strong>Pending</strong></td>
</tr>
</tbody>
</table>

#### Participatory Technology Assessment of NASA’s Asteroid Initiative

**Project/Proposal Title:**

**Source of Support:** National Aeronautics and Space Administration

**Total Award Amount:** $196,908

**Total Award Period Covered:** 4/1/14 – 3/31/15

**Location of Project:** Arizona State University

**Person-Months Per Year Committed to the Project:**

<table>
<thead>
<tr>
<th>Cal</th>
<th>Acad</th>
<th>Sumr</th>
</tr>
</thead>
</table>

#### ASU Site: National Nanotechnology Infrastructure Network – SEI Activities Supplement

**Project/Proposal Title:**

**Source of Support:** National Science Foundation (sub to Cornell University)

**Total Award Amount:** $65,000

**Total Award Period Covered:** 7/1/13 – 6/30/14

**Location of Project:** Arizona State University

**Person-Months Per Year Committed to the Project:**

<table>
<thead>
<tr>
<th>Cal</th>
<th>Acad</th>
<th>Sumr</th>
</tr>
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</table>

#### NSEC: Center for Nanotechnology in Society at Arizona State University (CNS-ASU Renewal)

**Project/Proposal Title:**

**Source of Support:** National Science Foundation

**Total Award Amount:** $6,500,000

**Total Award Period Covered:** 10/1/10 – 9/30/15

**Location of Project:** Arizona State University

**Person-Months Per Year Committed to the Project:**

<table>
<thead>
<tr>
<th>Cal</th>
<th>Acad</th>
<th>Sumr</th>
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#### NCCLCs: Material Life Cycle of Nanomaterials (LCNano)

**Project/Proposal Title:**

**Source of Support:** Environmental Protection Agency

**Total Award Amount:** $5,000,000

**Total Award Period Covered:** 12/1/2013 – 11/30/2018

**Location of Project:** Arizona State University

**Person-Months Per Year Committed to the Project:**

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<th>Cal</th>
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<th>Sumr</th>
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</table>

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
**Current and Pending Support**

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel.

<table>
<thead>
<tr>
<th>Investigator: Elizabeth A. Corley</th>
<th>National Science Foundation</th>
</tr>
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<tr>
<td>☒ Current</td>
<td>Pending</td>
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<tr>
<td>☑ Submissions in Near Future</td>
<td>☐ Transfer of Support</td>
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Project/Proposal Title:
Center for Nanotechnology in Society – ASU (Role: Co-Principal Investigator)

Source of Support: National Science Foundation
Total Award Amount: $12,700,000
Total Award Period Covered: October 2005 – September 2015
Location of Project: Arizona State University

Person-Months Per Year Committed to the:
Cal: 0  Acad: 0  Sumr: 0

Support:
☒ Current
☐ Pending
☐ Submission Planned in Near Future
☐ Transfer of Support

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

NSF Form 1239 (10/99)  USE ADDITIONAL SHEETS AS NECESSARY
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Cozzens, Susan</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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</thead>
</table>

**Support:**
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

### COLLABORATIVE RESEARCH: WOMEN IN SCIENCE AND TECHNOLOGY POLICY
**SES-1152980**
- **Source of Support:** National Science Foundation
- **Total Award Amount:** $179,487
- **Total Award Period Covered:** 5/15/12 – 4/30/15
- **Location of Project:** GTRC Atlanta, GA
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: .05

### CENTER FOR NANOTECHNOLOGY IN SOCIETY (CNS-ASU) AT GEORGIA TECH
**SES-0937591**
- **Source of Support:** Arizona State University
- **Total Award Amount:** $957,095
- **Total Award Period Covered:** 10/1/10 – 8/14/14
- **Location of Project:** GTRC Atlanta, GA
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: .05

### Source of Support:
- **Total Award Amount:** $
- **Total Award Period Covered:**
- **Location of Project:**
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:

### Support:
- [ ] Current
- [ ] Pending
- [ ] Submission Planned in Near Future
- [ ] *Transfer of Support

### Project/Proposal Title:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<thead>
<tr>
<th>Investigator: David Guston</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<td>Support:</td>
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<td>Current</td>
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<tr>
<td>Submission Planned in Near Future</td>
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<td>*Transfer of Support</td>
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<tr>
<td>Project/Proposal Title:</td>
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<tr>
<td>The Frankenstein Bicentennial Project (this proposal)</td>
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<td>Source of Support:</td>
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<td>Total Award Amount:</td>
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<td>Total Award Amount:</td>
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<td>Current</td>
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<td>Submission Planned in Near Future</td>
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<td>Project/Proposal Title:</td>
<td>Virtual Institute for Responsible Innovation</td>
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<td>Submission Planned in Near Future</td>
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<td>Project/Proposal Title:</td>
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<td>Total Award Amount:</td>
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<td>Total Award Period Covered:</td>
<td>July 2012 – June 2017</td>
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<td>Submission Planned in Near Future</td>
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<td>Project/Proposal Title:</td>
<td>To think, to write, to publish Part 2: Forging a working bond between next generation science communicators and next generation of science and technology policy leaders</td>
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<tr>
<td>Source of Support:</td>
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<td>January 2012 – June 2013</td>
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<td>Person-Months Per Year Committed to the Project:</td>
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<td>Current</td>
<td>Pending</td>
</tr>
<tr>
<td>Submission Planned in Near Future</td>
<td></td>
</tr>
<tr>
<td>*Transfer of Support</td>
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<tr>
<td>Project/Proposal Title:</td>
<td>QESST: ERC for Quantum Energy and Sustainable Solar Technologies</td>
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<tr>
<td>Source of Support:</td>
<td>National Science Foundation</td>
</tr>
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<td>Total Award Amount:</td>
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<tr>
<td>Total Award Period Covered:</td>
<td>March 1, 2011 – February 29, 2016</td>
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<td>Location of Project:</td>
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<td>Person-Months Per Year Committed to the Project:</td>
<td>0.00 Cal: 0.00 Acad: 0.00 Sumr: 0.00</td>
</tr>
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</table>
Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support
Project/Proposal Title: NSEC: Center for Nanotechnology and Society at ASU Renewal
Source of Support: National Science Foundation
Total Award Amount: $6,500,000 Total Award Period Covered: October 1, 2010 – September 30, 2015
Location of Project: Arizona State University
Person-Months Per Year Committed to the Project: Cal: Acad: Sumr:

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support
Project/Proposal Title: Socio-Technical Integration Research (STIR)
Source of Support: National Science Foundation
Total Award Amount: $540,000 Total Award Period Covered: April 1, 2009 – March 30, 2012
Location of Project: Arizona State University
Person-Months Per Year Committed to the Project: Cal: Acad: Sumr: .25 yr

Support: ☒ Current ☐ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support
Project/Proposal Title: Participatory Technology Assessment of NASA’s Asteroid Initiative
Source of Support: NASA
Total Award Amount: $196,908 Total Award Period Covered: April 1, 2014 – March 31, 2015
Location of Project: Arizona State University
Person-Months Per Year Committed to the Project: Cal: Acad: Sumr:

Support: ☐ Current ☒ Pending ☐ Submission Planned in Near Future ☐ Transfer of Support
Project/Proposal Title: Cross-training in Biomedical Research: Business, Policy, Law, and Communications
Source of Support: NIH
Total Award Amount: $1,931,250 Total Award Period Covered: September 1, 2014 – August 31, 2019
Location of Project: Arizona State University
Person-Months Per Year Committed to the Project: Cal: Acad: Sumr:
# Current and Pending Support

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Jose Lobo</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<table>
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<tr>
<th>Support:</th>
<th>X Current</th>
<th>□ Pending</th>
<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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</table>

**Project/Proposal Title:**

### NSEC: Center for Nanotechnology in Society at Arizona State University

Source of Support: National Science Foundation  
Total Award Amount: $6,500,000  
Total Award Period Covered: September 2010-August 2015  
Location of Project: Arizona State University  
Person-Months Per Year Committed to the Project:  
Cal: Acad: Sumr: 1.0

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<th>□ Pending</th>
<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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**Project/Proposal Title:**

### Dynamics of Global Informal Settlements

Source of Support: Bill & Melinda Gates Foundation  
Total Award Amount: $19,038  
Total Award Period Covered: January 2013 – January 2015  
Location of Project: Santa Fe Institute  
Person-Months Per Year Committed to the Project:  
Cal: Acad: Sumr: 2.0

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<th>□ Pending</th>
<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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**Project/Proposal Title:**

### Forecasting Progress in Solar Energy Technologies

Source of Support: U.S. Department of Energy  
Total Award Amount: $61,340  
Total Award Period Covered: April 1, 2013 – April 1, 2016  
Location of Project: UNC-Charlotte  
Person-Months Per Year Committed to the Project:  
Cal: Acad: Sumr:

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<tr>
<th>Support:</th>
<th>□ Current</th>
<th>□ Pending</th>
<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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**Project/Proposal Title:**

### Another Project

Source of Support:  
Total Award Amount: $  
Total Award Period Covered:  
Location of Project:  
Person-Months Per Year Committed to the Project:  
Cal: Acad: Sumr:

<table>
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<tr>
<th>Support:</th>
<th>□ Current</th>
<th>□ Pending</th>
<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
</tr>
</thead>
</table>

**Project/Proposal Title:**

---

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Clark A. Miller</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current and Pending Support</td>
</tr>
<tr>
<td>(See GPG Section II.D.8 for guidance on information to include on this form.)</td>
</tr>
</tbody>
</table>

### The Socio-Economics of Energy Transitions: Research and Training Initiative (this proposal)
- **Project/Proposal Title:** The Socio-Economics of Energy Transitions: Research and Training Initiative (this proposal)
- **Source of Support:** National Science Foundation
- **Total Award Amount:** $499,086
- **Total Award Period Covered:** 10/1/2014 – 9/30/2017
- **Location of Project:** Arizona State University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: 0.5

### Other agencies (including NSF) to which this proposal has been/will be submitted.

<table>
<thead>
<tr>
<th>Support:</th>
<th>Current</th>
<th>Pending</th>
<th>Submission Planned in Near Future</th>
<th>*Transfer of Support</th>
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</thead>
<tbody>
<tr>
<td>Current</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

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### Quantum Energy and Sustainable Solar Technologies (QUEST) Engineering Research Center
- **Project/Proposal Title:** Quantum Energy and Sustainable Solar Technologies (QUEST) Engineering Research Center
- **Source of Support:** National Science Foundation
- **Total Award Amount:** $18,500,000
- **Total Award Period Covered:** 8/15/11-8/14/16
- **Location of Project:** Arizona State University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: 0.5

### RCN-SEE: Sustainable Energy Systems
- **Project/Proposal Title:** RCN-SEE: Sustainable Energy Systems
- **Source of Support:** National Science Foundation
- **Total Award Amount:** $750,000
- **Total Award Period Covered:** 9/1/11-8/31/16
- **Location of Project:** Arizona State University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: 0.25

### IGERT: Person-centered Technologies and Practices for Individuals with Disabilities
- **Project/Proposal Title:** IGERT: Person-centered Technologies and Practices for Individuals with Disabilities
- **Source of Support:** NSF
- **Total Award Amount:** $3,000,000
- **Total Award Period Covered:** 7/1/11-6/30/16
- **Location of Project:** Arizona State University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr: 1.0

### Knowledge Systems Analysis for Environmental Decision Making: Energy Development in the Four Corners Region of the American Southwest, 1960-2010
- **Project/Proposal Title:** Knowledge Systems Analysis for Environmental Decision Making: Energy Development in the Four Corners Region of the American Southwest, 1960-2010
- **Source of Support:** National Science Foundation
- **Total Award Amount:** $120,000
- **Total Award Period Covered:** 4/15/12 – 3/31/2015
- **Location of Project:** Arizona State University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:

### Center for Nanotechnology in Society: Renewal
- **Project/Proposal Title:** Center for Nanotechnology in Society: Renewal
- **Source of Support:** National Science Foundation
- **Total Award Amount:** $6,500,000
- **Total Award Period Covered:** 10/1/10-9/30/15
- **Location of Project:** Arizona State University
- **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:
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<td>Deliberative Approaches to Evidence-based Decision-making in Personalized Medicine Based on Whole Systems Assessment Technologies</td>
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<td>Person-Months Per Year Committed to the Project.</td>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.
## Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<thead>
<tr>
<th>Investigator: Dietram Scheufele</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted.</th>
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<th>x Current</th>
<th>□ Pending</th>
<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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Project/Proposal Title: NIRT: Center for Nanotechnology in Society at Arizona State University

- **PI:** David Guston
- **Source of Support:** NSF
- **Total Award Amount:** $6.5mio
- **Total Award Period Covered:** 2010-15
- **Location of Project:** ASU with UW-Madison subcontract
- **Person-Months Per Year Committed to the Project:** Cal: 1.5 Acad: 0 Sumr: 0

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<tr>
<th>Support:</th>
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<th>□ Pending</th>
<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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Project/Proposal Title: Developing a user experience for the next generation nuclear fuel cycle simulator

- **PI:** Paul Wilson
- **Source of Support:** Department of Energy
- **Total Award Amount:** $1.2mio
- **Total Award Period Covered:** 2011-14
- **Location of Project:** UW-Madison
- **Person-Months Per Year Committed to the Project:** Cal: 0.25 Acad: 0 Sumr: 0

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<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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</table>

Project/Proposal Title: UW Nanoscale Science and Engineering Center on Templated Synthesis and Assembly at the Nanoscale

- **PI:** Padma Gopalan
- **Source of Support:** NSF
- **Total Award Amount:** $14.7mio
- **Total Award Period Covered:** 2009-14
- **Location of Project:** UW-Madison
- **Person-Months Per Year Committed to the Project:** Cal: 0.25 Acad: 0 Sumr: 0

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<th>□ Submission Planned in Near Future</th>
<th>□ *Transfer of Support</th>
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Project/Proposal Title: Subcontract to "Nanoscale Informal Science Education Network"

- **PIs:** Larry Bell, Paul Martin & Robert J. Semper
- **Source of Support:** NSF
- **Total Award Amount:** $159,989
- **Total Award Period Covered:** 2013-15
- **Location of Project:** UW-Madison
- **Person-Months Per Year Committed to the Project:** Cal: 0.25 Acad: Sumr: +

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

---

NSF Form 1239 (10/99) USE ADDITIONAL SHEETS AS NECESSARY
**Current and Pending Support**

(See GPG Section II.D.8 for guidance on information to include on this form)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<tr>
<th>Investigator:</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted:</th>
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<td>Cynthia Selin</td>
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**Support:**
- Current
- Pending
- Submission Planned in Near Future
- *Transfer of Support

**Project/Proposal Title:**
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   - **Democratizing Science: The Role of Informal Civic Learning in Shaping Sociotechnical Futures**
   - **This Proposal?** ☒
   - **Source of Support:** National Science Foundation
   - **Total Award Amount:**
   - **Location of Project:** Arizona State University
   - **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:

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   - **Source of Support:**
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   - **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:

3. **Submission Planned in Near Future:**
   - **This Proposal?**
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   - **Total Award Amount:**
   - **Location of Project:**
   - **Person-Months Per Year Committed to the Project:** Cal: Acad: Sumr:

4. **Transfer of Support:**

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
### Current and Pending Support

(See GPG Section II.D.8 for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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<th>Investigator: Philip Shapira</th>
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**Support:**

- Current
- Pending
- Submission Planned in Near Future
- *Transfer of Support

**Project/Proposal NSEC/Center for Nanotechnology in Society at Arizona State University (Georgia Tech sub-contract)**

Source of Support: National Science Foundation

- Total Award Amount: $1,139,173
- Total Award Period Covered: October 1, 2010 – September 30, 2015

Location of Project: Georgia Institute of Technology, Atlanta (sub-contract through Arizona State University)

Person-Months Per Year Committed to the Project: Cal: 1 Acad: Sumr:

**Support:**

- Current
- Pending
- Submission Planned in Near Future
- *Transfer of Support

**Project/Proposal Title:**

Georgia Manufacturing Survey

Source of Support: Enterprise Innovation Institute

- Total Award Amount: $10,000
- Total Award Period Covered: 8/1/13 – 7/31/14

Location of Project: Georgia Institute of Technology, Atlanta

Person-Months Per Year Committed to the Project: Cal: 0.8 Acad: Sumr:

**Support:**

- Current
- Pending
- Submission Planned in Near Future
- *Transfer of Support

**Project/Proposal Title:**

International University Research Ventures: Implications for US Economic Competitiveness and National Security

Source of Support: Minerva Research Initiative (DoD)

- Total Award Amount: $945,000
- Total Award Period Covered: 9/2014 – 8/2017

Location of Project: Georgia Institute of Technology, Atlanta

Person-Months Per Year Committed to the Project: Cal: Acad: Sumr: 1

**Support:**

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- Pending
- Submission Planned in Near Future
- *Transfer of Support

**Project/Proposal Title:**

Total Award Amount: 
Total Award Period Covered:

Location of Project: Georgia Tech, Atlanta

Person-Months Per Year Committed to the Project: Cal: Acad: Sumr:

**Support:**

- Current
- Pending
- Submission Planned in Near Future
- *Transfer of Support

**Project/Proposal Title:**

Total Award Amount: 
Total Award Period Covered:

Location of Project: 
Person-Months Per Year Committed to the Project: Cal: Acad: Sumr:

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

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NSF Form 1239 (10/99)  USE ADDITIONAL SHEETS AS NECESSARY
## Current and Pending Support

*(See GPG Section II.C.2.h for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding Period.
## Current and Pending Support

(See GPG Section II.C.2.h for guidance on information to include on this form.)

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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| **Project/Proposal Title:**            | NSEC/Center for Nanotechnology at ASU |
| **Source of Support:**                 | NSF-SES |
| **Total Award Amount:**                | $6,525,890.00 |
| **Total Award Period Covered:**        | 9/15/2010 - 8/31/2015 |
| **Location of Project:**               | Arizona State University |
| **Person-Months Per Year Committed to the Project.** | Cal: 0 Acad: 4 Sumr: .5 |

| **Support:**                          | **Pending** **Submission Planned in Near Future** **Transfer of Support** |
| **Project/Proposal Title:**            | Developing and Assessing Macroethics Modules for the Collaborative Institutional Training Initiative Responsible Conduct of Research Courses |
| **Source of Support:**                 | NSF-SES |
| **Total Award Amount:**                | $264,292.00 |
| **Total Award Period Covered:**        | 10/1/2010 - 9/30/2013 |
| **Location of Project:**               | Arizona State University |
| **Person-Months Per Year Committed to the Project.** | Cal: 0 Acad: .25 Sumr: .25 |

<p>| <strong>Support:</strong>                          | <strong>Pending</strong> <strong>Submission Planned in Near Future</strong> <strong>Transfer of Support</strong> |
| <strong>Project/Proposal Title:</strong>            | Partnership for Education on Climate Change, Engineered Systems, and Society |
| <strong>Source of Support:</strong>                 | NAE |
| <strong>Total Award Amount:</strong>                | $217,936.00 |
| <strong>Total Award Period Covered:</strong>        | 9/15/2010 - 8/31/2013 |
| <strong>Location of Project:</strong>               | Arizona State University |
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The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

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| Project/Proposal Title: | NSEC: Center for Nanotechnology in Society at Arizona State University (renewal) |
| Source of Support: | National Science Foundation |
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| Location of Project: | Arizona State University |
| Person-Months Per Year Committed to the Project: | Cal:  | Acad:  | Sumr: |

| Project/Proposal Title: | NUE: Cross-disciplinary Education in Social & Ethical Aspects of Nanotechnology |
| Source of Support: | National Science Foundation |
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| Location of Project: | Arizona State University |
| Person-Months Per Year Committed to the Project: | Cal:  | Acad:  | Sumr: |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*
Current and Pending Support  

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Investigator: Cynthia Selin

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<th>Submission Planned in Near Future</th>
<th>*Transfer of Support</th>
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<td>Source of Support:</td>
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<td>Total Award Amount:</td>
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*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.

NSF Form 1239 (10/99)
# Current and Pending Support

*(See GPG Section II.D.8 for guidance on information to include on this form.)*

The following information should be provided for each investigator and other senior personnel. Failure to provide this information may delay consideration of this proposal.

<table>
<thead>
<tr>
<th>Investigator: Jan Youtie</th>
<th>Other agencies (including NSF) to which this proposal has been/will be submitted: NSF</th>
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<tr>
<td>Support:</td>
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<tr>
<td>Project/Proposal Title:</td>
<td>Center for Nanotechnology in Society – Arizona State University</td>
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**Source of Support: Arizona State University and National Science Foundation**

- **Total Award Amount:** $800,000
- **Total Award Period Covered:** 10/1/10-9/30/15
- **Location of Project:** Georgia Tech
- **Person-Months Per Year Committed to the Project:** Cal: 1.1 Acad: Sumr:

| Support:                | ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support |
| Project/Proposal Title: | Credibility and Use of Scientific and Technical Information in Science Policy Making: An Analysis of the Information Basis of the National Research Council’s Committee Reports |

**Source of Support: National Science Foundation**

- **Total Award Amount:** $350,000
- **Total Award Period Covered:** 9/1/2013 - 8/31/2015
- **Location of Project:** University of Georgia and Georgia Tech
- **Person-Months Per Year Committed to the Project:** Cal: 1.5 Acad: Sumr:

| Support:                | ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support |
| Project/Proposal Title: | Connections: STEM Educational Research Communities and Knowledge Transfer |

**Source of Support: National Science Foundation**

- **Total Award Amount:** $283,269
- **Total Award Period Covered:** 05/01/2014 - 4/30/2016
- **Location of Project:** Search Technology and Georgia Tech
- **Person-Months Per Year Committed to the Project:** Cal: 1.3 Acad: Sumr:

| Support:                | ☑ Current ☐ Pending ☐ Submission Planned in Near Future ☐ *Transfer of Support |
| Project/Proposal Title: |                                      |

*If this project has previously been funded by another agency, please list and furnish information for immediately preceding funding period.*

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**NSF Form 1239 (10/99)**

**USE ADDITIONAL SHEETS AS NECESSARY**

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